998. Physical Chemistry Seminar

Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this

course.
R: Open only to graduate students in Chemistry.
Advances in physical chemistry reported by graduate

QA: CEM 998

999. **Doctoral Dissertation Research**

Fall, Spring, Summer. 1 to 20 credits. A student may earn a maximum of 99 credits in all enrollments for this course. R: Open only to graduate students in Chemistry.

QA: CEM 999

CHINESE

CHS

Department of Linguistics and Germanic, Slavic, Asian and African Languages College of Arts and Letters

101. Elementary Chinese I

Fall. 4(4-1)

Pronunciation, writing system, and basic vocabulary and sentence patterns, with emphasis on conversation. QA: CHS 101, CHS 102

Elementary Chinese II Spring. 4(4-1) 102.

P: CHS 101 or approval of department. Further work on conversation, character writing, and comprehension, with increasing emphasis on vocabulary building and grammar.

QP: CHS 101 QA: CHS 102, CHS 103

Second-Year Chinese I 201.

Fall. 4(4-1)

P: CHS 102 or approval of department. Intermediate-level work on skills in conversation, comprehension, and grammar. Practice in composi-

QP: CHS 103 QA: CHS 201, CHS 202

202. Second-Year Chinese II

Spring. 4(4-1)
P: CHS 201 or approval of department.
Further intermediate-level work on skills in conversation, comprehension, and grammar. Continued prac-

tice in composition. QP: CHS 201 QA: CHS 202, CHS 203

Third-Year Chinese I

Fall. 4(4-0) P: CHS 202.

Advanced-level work on speaking, listening comprehension, reading, and writing skills, based on materials of cultural interest.

QP: CHS 203 QA: CHS 301, CHS 302

302. Third-Year Chinese II

Spring. 4(4-0) P: CHS 301.

Advanced-level work on speaking, listening comprehension, reading, and writing skills, based on materials of cultural interest.

QP: CHS 301, CHS 321 QA: CHS 302, CHS 303

350. Studies in the Chinese Language

Spring. 3(3-0)
P: CHS 201 or approval of department. Chinese phonology, morphology, and syntax. QP: CHS 203

Fourth-Year Chinese I

Fall. 3(3-0)

P: CHS 302.

Reading, discussion and writing based on original materials, including classical texts of cultural interest. QP: CHS 303, CHS 321 QA: CHS 401, CHS 431

402. Fourth Year Chinese II

Spring. 3(3-0) P: CHS 401.

Further reading, discussion and writing based on original materials, including classical texts of broad cultural interest.

QP: CHS 303, CHS 321 QA: CHS 401, CHS 420

499. Senior Thesis Research

Fall, Spring. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.

R: Approval of department.

An individual research project supervised by a faculty member that demonstrates the student's ability to do independent research and submit or present a major

CIVIL ENGINEERING

CE

Department of Civil Engineering College of Engineering

271. Engineering Surveying Fall, Spring. 4(3-3)

P: MTH 120.

Application of surveying and error analysis to civil engineering problems. Earth work. Calculations. Layout and management of construction sites. QP: MTH 112 QA: CE 252, CE 251

Introduction to Environmental

Engineering Fall, Spring. 3(3-0) P: CEM 141 or CEM 151, MTH 132, CPS 130 or CPS

Elements of hydrology. Groundwater and surface water supply and contamination. Treatment systems for drinking water, wastewater, air, and solid and hazardous waste. Introduction to noise and radiation

QP: CEM 141, CEM 151, MTH 112, CPS 112 QA: $\dot{C}E$ 280.

305. Structural Analysis

Fall, Spring. 3(3-0)
P: MSM 211, CE 390 or concurrently. R: Open only to Civil Engineering majors.

Determinate and indeterminate plane structures.

Linearity, stability, determinacy. Virtual-work calculation of forces and displacements. Flexibility and stiffness methods in plane structures. QP: MMM 211 QA: CE 305, CE 306

312. Soil Mechanics

Fall, Spring. 3(2-3)
P: MSM 211. R: Open only to Civil Engineering and

Agricultural Engineering majors. Engineering properties of soil and their measurement. Effective-stress concept. Permeability and seepage. Compaction. Consolidation, shear strength and stressstrain behavior. QP: MMM 211 QA: CE 312

Introduction to Fluid Mechanics

Fall, Spring. 4(3-2) P: MSM 306 or concurrently. R: Open only to Civil Engineering and Agricultural Engineering majors. Not

open to students with credit in ME 332.
Fluid properties, fluid statics, fluids in motion. Conservation of mass, energy and momentum. Dimensional analysis and similitude. Internal and external flows. Applications. QP: MTH 310, MMM 306 QA: CE 321

Civil Engineering Materials I

Fall, Spring. 4(3-3)

P: MSM 211 or concurrently. R: Open only to Civil Engineering majors.

Common civil engineering construction and paving materials: aggregates, inorganic cements, asphalts, concretes, wood and steel. Composition, structure physical and mechanical properties, tests, and produc-

tion mix design. QP: MMM 211 QA: CE 308

346. Transportation

Fall, Spring. 3(3-0)
P: MTH 133. R: Open only to Civil Engineering, Engineering Arts, and Urban Planning students.

Planning, design, and evaluation of transportation systems. Transportation demand, capacity, delay, and service quality. Elements of geometric design. *QP: MTH 113 QA: CE 346*

370. Engineering Economics

Fall, Spring. 3(3-0)

P: MTH 133. R: Open only to College of Engineering students

Economic decision making in the context of evaluation of engineering projects. Net present worth and related methods of analysis. Depreciation. Before- and aftertax analysis. Sensitivity analysis, inflation, expected

QP: MTH 113 QA: CE 370

373 Construction Estimating and Scheduling

Fall. 3(3-0) R: Open only to College of Engineering and Building Construction Management majors.

Estimating quantities and costs for construction projects. Optimal scheduling of personnel and equipment subject to constraints and uncertainty. QA: CE 372 CE 471

390. Civil Engineering Analysis
Fall, Spring. 3(3-0)
P: CPS 130 or CPS 131; MTH 235; MSM 211 or concurrently. R: Open only to College of Engineering

Application of numerical methods and computing to civil engineering problems. Random variables in civil engineering. Problem solving methods. Report preparation. QP: CPS 112, MTH 310, MMM 211 QA: CE 390

400. Structural Mechanics

Fall. 3(3-0)
P: CE 305, CE 390. R: Open only to Civil Engineering majors.

Matrix methods of structural analysis. Flexibility method. Direct stiffness method for plane structures. Elastic supports, inclined supports, member releases and non-prismatic members. Application software. QP: CE 306, CE 390 QA: CE 400, CE 410

405. Design of Steel Structures

Fall, Spring. 3(3-0)
P: CE 305. R: Open only to Civil Engineering majors.
Design of steel beams, columns, tension members and connections. Stability and plastic strength.
QP: CE 306, CE 390 QA: CE 405

Design of Concrete Structures

Fall, Spring, Summer. 3(3-0) P: CE 305, CE 337. R: Open only to Civil Engineering majors.

Design of reinforced concrete beams, slabs, columns and footings. QP: CE 306, CE 308, CE 390 QA: CE 406

Structural System Design

Spring. 3(3-0)

P: CE 405 or concurrently; CE 406. R: Open only to Civil Engineering majors. Building or bridge design using steel, concrete, wood,

or other materials. Approximate methods. Wind and earthquake forces. QP: CE 405, CE 406 QA: CE 407

Geotechnical Engineering

Fall. 4(4-0) P: CE 312, CE 390. R: Open only to Civil Engineering majors.

Shallow foundation design including bearing capacity, stress distribution, and settlement analysis. Pile foundations. Design of retaining structures including rigid walls, braced excavations, and sheet-pile walls. Stability of slopes and embankments. QP: CE 312, CE 390 QA: CE 418, CE 419

Engineering Hydrology

P: STT 351; CE 321 or concurrently. R: Open only to College of Engineering, College of Natural Science, and Crop and Soil Sciences majors.

Hydrologic cycle, streamflow, precipitation, evapotranspiration, infiltration, groundwater. Quantitative methods of analysis: probability, unit hydrograph, routing, and flow nets. Groundwater supply develop-

ment, well flows. QP: CE 321, STT 351 QA: CE 421

422. Applied Hydraulics

Spring. 3(2-2)
P: CE 321 or ME 332: CE 390 or ME 391. R: Open only to Civil Engineering, Mechanical Engineering, and Agricultural Engineering majors.

Fundamentals of open-channel flow. Rapidly and gradually varied nonuniform flow analysis. Confined flows past submerged bodies, in pipe networks, and in turbo machinery. Design applications. QP: CE 321, CE 390 QA: CE 422, CE 423

Pavement Design and Analysis I 431,

P: CE 312, CE 337. R: Open only to Civil Engineering

Highway and airfield pavement structural design. Performance measures. Failure mechanisms, popular thickness design procedures, and design considerations for surface friction, pavement joints, and drain-

age. OP: CE 308 QA: CE 494

433. Rehabilitation of Highway and Airfield Pavements

Spring of odd-numbered years. 3(3-0) P: CE 431 R: Open only to Civil Engineering majors. Distress mechanisms. Developing and conducting quantitative surveys for structural and functional evaluation. Development of maintenance and rehabilitation strategies. Predictive performance models. QP: CE 494 QA: CE 842

Highway Operations Fall. 3(3-0) 441.

P: STT 351, CE 346. R: Open only to Civil Engineer-

ing majors.

Driver and vehicle characteristics affecting traffic flow. Traffic flow density, highway speed and capacity. Signal control of intersections and networks. Risk management and liability. QP: STT 351, CE 346 QA: CE 441

Airport Planning and Design

Spring. 3(3-0)

P: CE 346. R: Open only to Civil Engineering majors. Components of the airport system including ground access facilities, aircraft characteristics, air traffic control, airport configuration, capacity analysis. QP: CE 346 QA: CE 442

448. Transportation Planning

Spring. 3(3-0) P: CE 346, STT 351. R: Open only to Civil Engineer-

ing majors.

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" procedures. Traffic impact of new facilities. QP: CE 346, STT 351 QA: CE 448

449. Highway Design

Fall. 4(3-3)

P: CE 271, CE 346, R: Open only to Civil Engineering

Geometric design of highways as related to operation, capacity and safety. Alignment, drainage and pave-ment design. The use of CAD systems in preparing contract plans. QP: CE 346, CE 252 QA: CE 347

474. Contracts and Ethics

Spring. 3(3-0)

R: Open only to College of Engineering and Building Construction Management seniors and graduate stu-

Contract and specification preparation. Concepts of liability. Case studies in professional ethics. QA: CE 374

480. Water and Wastewater Analysis Laboratory

Fall. 1(0-3)

C: CE 481 R: Open only to majors in Civil Engineering and Environmental Engineering.

Chemical and microbial analysis of water and waste-

water. QP: CEM 384, STT 351 QA: CE 481

481. Environmental Engineering Chemistry

Fall. 3(3-Ŏ)

P: CEM 361, CHE 201, CE 280.

Chemistry of environmental processes including alkalinity, precipitation-dissolution reactions, chemical complexation and redox reactions. Engineering applications to processing plants for water and waste-

water. QP: CEM 384, STT 351 QA: CE 481

483. Water and Wastewater Treatment

Fall. 3(3-0)

P: CE 280, CE 321. R: Open only to Civil Engineering majors.

Distribution of water and collection of sewage. Theory and design of water treatment processes. QP: CE 280, CE 321 QA: CE 483

Solid and Hazardous Waste Management

Spring. 3(3-0)
P: CE 280. R: Open only to College of Engineering majors.

Design of solid waste collection and disposal systems. Definition of hazardous waste problems and selection of treatment alternatives. QP: CE 280 QA: ENE 832, ENE 816

Microbiology for Environmental Health Engineering

Spring. 3(3-0)

P: CEM 361, CHE 201. R: Open only to College of Engineering majors.

Use and control of microorganisms for the protection of public health and the environment. Thermodynamics of microbial populations and microbial transformations.

QP: CEM 361, CHE 300

490. Independent Study

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course.

R: Open only to Civil Engineering majors. Approval

of department. Civil engineering problem of specific interest to the student and a faculty member. May be analysis or design. QA: CE 499

Civil Engineering Design Project 491.

Fall, Spring. 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this

R: Open only to Civil Engineering majors. Approval of department.

Planning, specification, and design of a civil engineering project or facility. QA: CE 494

801. Experimental Methods for Structures and Materials

Spring of even-numbered years. 3(2-2) Principles of instrumentation and experimental measurement techniques for materials and structural systems. Statistical methods for design and analysis of experiments.

QP: CE 308 QA: CE 801

802. Structural Dynamics

Fall. 3(3-0)

Dynamic loads and characteristics of structures. Steady-state and transient behavior. Numerical solutions and method of normal modes. Applications such as earthquake engineering. QP: CE 405, CE 406 QA: CE 802

804. Advanced Structural Mechanics I Fall. 3(3-0)

Advanced linear structural mechanics. Potential energy principle. Finite element formulations. Applications to space frames. Plates and shell structures. *QP: CE 400 QA: CE 804*

Advanced Design of Steel Structures

Spring. 3(3-0)
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. QP: CE 405 QA: CE 906

806. Advanced Design of Reinforced Concrete

Fall of even-numbered years. 3(3-0)
Analysis and design of reinforced concrete components under multiaxial loads. Modeling, analysis and design of continuous reinforced concrete systems. QP: CE 406 QA: CE 805

807. Concrete Materials and Technology

Summer. 3(3-0)

Concrete properties and production, structure-property relations. Advances in concrete technology. Special engineering applications. QP: CE 308 QA: CE 890, CE 803

Prestressed Concrete Structures Fall of odd-numbered years. 3(3-0)

Prestressing principles, methods and materials. Analysis and design of prestressed concrete elements and structures

QP: CE 406 QA: CE 806

Reliability-Based Design in Civil Engineering Fall. 3(3-0)

Probabilistic treatment of live and dead loads: earthquakes, floods, material properties, and capacity. Reliability basis of design specifications, reliability index, probability of failure, design for reliability. Reliability of engineering systems. QP: STT 351, CE 406, CE 418 QA: CE 890

812. Mechanical Properties of Soils

Fall. 3(2-3)

Permeability, consolidation theory, stress-strain behavior, conditions of failure, shear strength. Laboratory determination of soil properties including interpretation of experimental data. QP: CE 418, CE 419 QA: CE 817

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. QP: CE 418 QA: CE 815, CE 819, CE 820

818. Advanced Geotechnical Design

Spring. 3(3-0)

Foundations and earth retaining structures. Bearing capacity, settlement, and lateral resistance of deep foundations. Advanced design of retaining structures using in-situ test data. Numerical solution of geotechnical problems. QP: CE 418, CE 419 QA: CE 818

821. Groundwater Hydraulics

Fall. 3(3-0)

Physical properties of porous media. Equations of flow in saturated media. Flow nets, well flow and parameter measurement. Transport processes and the advective dispersion equation for conservative contaminants. QP: CE 321, CE 421 QA: CE 821

822. Experimental Fluid Mechanics in Civil Engineering

Fall of even-numbered years. 3(1-6) Design and conduct of laboratory experiments in fluid mechanics. Computer-based data acquisition, Interpretation and analysis of experimental data. QP: CE 422

826. Environmental Fluid Mechanics

Spring. 3(3-0)

Pollutant dispersion: mixing phenomena, molecular diffusion, turbulent dispersion, shear flow dispersion. The convective-diffusion equation: analytical solutions, simplified solutions. Momentum, mass and heat transport. QP: CE 321, CE 423 QA: CE 826

Free Surface Flow

Spring of even-numbered years. 3(3-0) Steady and unsteady open-channel flow: profile synthesis, surge and wave phenomena, computer modeling. Coastal engineering: wave theory, wave statistics, breakwater design. QP: CE 422 QA: CE 828, CE 824

829. Fluid Transients

Spring of even-numbered years. 3(3-0) Application of unsteady flow concepts and wave mechanics to hydraulic engineering: method of characterresonance phenomena. QP: CE 321 QA: CE 829

Pavement Design and Analysis II Spring. 3(3-0)

Theoretical models for analysis of pavement systems. Evaluation and application of current design practices related to elastic and plastic theory. Formulation of improved design procedures. QP: CE 494 QA: CE 840

Engineering Management of Pavement Networks 835.

Spring of odd-numbered years. 3(3-0) Theoretical and statistical analysis of pavement networks. Engineering monitoring. Determination of distress mechanisms and engineering solutions. Assignment of priorities to the engineering actions. QA: CE 890

837. Transportation Materials Engineering

Fall of even-numbered years. 3(3-0) Engineering characteristics of soils and materials commonly used in transportation facilities. Relationships of material engineering properties to pavement design and performance. Material behavior under cyclic loading. QP: CE 418 QA: CE 815

Selected Topics in Highway and Airfield Engineering 838.

Fall of odd-numbered years. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course.

Topics in pavement engineering such as nondestruc-tive deflection testing and back calculation of layer moduli, advanced application of finite element theory in slab design, or fracture mechanics analyses of joint and crack performance. QP: CE 494

Stabilizing Unbound Granular 839. Materials

Fall of even-numbered years. 3(3-0) P: CE 431.

Improving performance and engineering properties of various granular materials through the use of mechanical processes, and chemical or mineralogical additives. Characterization of engineering properties of stabilized materials. QP: CE 418 QA: CE 819

Traffic Flow Theory

Spring. 3(3-0) Microscopic and macroscopic traffic flow models, Queueing theory. Gap acceptance. Simulation models for network analysis. Intelligent vehicle highway

QP: STT 351 QA: CE 843

Advanced Airport Systems Design

Fall of odd-numbered years. 3(3-0) Analysis and design of airport systems using computer models. Design parameters, demand analysis. Runway orientation and capacity, airside delay, vehicle processing. Passenger processing. QP: CE 442

Simulation and Optimization of 843. Urban Traffic Flow

Fall of even-numbered years. 3(3-0)

P: CE 841. Statistical analysis of highway geometric designs and operational-control strategies with respect to the optimal flow of traffic: intersection, arterial, network design and control models. Traffic simulation. System

management and optimization. QP: CE 441, CE 449 QA: CE 841

Highway and Traffic Safety R44

Fall of odd-numbered years. 3(3-0)
Analysis of highway geometric design alternatives and operational-control strategies with respect to accident probabilities. Statistical methods of pattern identification. Countermeasure selection and evaluation methodology. Risk management.

QP: CE 843, STT 423 QA: CE 844

845. Public Transportation System

Planning
Fall of odd-numbered years. 3(3-0) Planning and operating urban and rural transportation systems. System technology and management. Budgeting and programming of transportation services. Environmental impact statements. Paratransit and demand-responsive systems. QP: CE 346 QA: CE 845, CE 941

Statewide Transportation Network 846. Evaluation

Spring of even-numbered years, 3(3-0) Transportation system measures, needs studies, sufficiency ratings. Cost allocation models, programming and budget constraints. Corridor analysis, transportation economics, demand elasticity. QP: CE 346 QA: CE 846

Travel Demand Analysis 848.

Fcll of even-numbered years. 3(3-0)
Advanced topics in travel demand modeling. Disaggregate and behavioral models, error analysis, and model sensitivity. Economic investment and analysis in demand context. Activity modeling. QP: CE 448 QA · CE 848

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, QP: CE 351 QA: CE 849

Independent Study in Civil 890.

Engineering
Fall, Spring, Summer. 1 to 4 credits. A
student may earn a maximum of 9 credits in all enrollments for this course. R: Approval of department.

Research problems of limited scope not pertaining to thesis accomplished under CE 899 or CE 999. QA: CE 880

Selected Topics in Civil Engineering Fall, Spring, Summer. 2 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. QA: CE 890

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.

QA: CE 899

902. Random Vibration of Structural and Mechanical Systems

Spring of even-numbered years. 3(3-0)
Interdepartmental with Mechanical Engineering and Materials Science and Mechanics.

P. CE 802 or ME 860, CE 810 or STT 351.

Probabilistic modeling of random excitations (e.g., earthquake, aerodynamic, and ocean wave loadings).

Response of single and multiple degree of freedom systems to random excitation. Designing against failure. Nonstationary and nonlinear problems. QP: CE 802, ME 823, STT 351, STT 441 QA: CE

Advanced Structural Mechanics II 904.

Spring. 3(3-0) P: CE 804.

Complementary energy, hybrid finite element, applica-tions of plasticity theory. Nonlinear analysis of frames. Nonlinear finite elements. Computer implementation. QP: CE 804 QA: CE 890

906.

Advanced Theory of Concrete Composites and Structures Spring of odd-numbered years. 3(3-0)

P: CE 806. Applications of fracture mechanics and plastic theories to modeling the mechanical behavior of concrete composites and structures. Fiber reinforced concrete. QP: CE 406 QA: CE 905, CE 803

915. Earth Structures

Fall of odd-numbered years. 3(3-0)

P: CE 812.

Design of earth dams and embankments. Natural and cut slopes, slope stability analysis. Embankments on soft foundations, seepage analysis, earth reinforcement. Instrumentation. QP: CE 817 QA: CE 915

Soil Dynamics

Spring. 3(3-0) P: CE 812.

Vibration fundamentals and wave propagation in soil media. Dynamic soil properties. Theory and design of foundations for vibratory loads. Characteristics of ground motion during earthquakes. Soil liquefaction. Settlement under transient and repeated load QP: CE 817 QA: CE 916

Advanced Topics in Groundwater

Spring of even-numbered years, 3(3-0)

Formulation and use of numerical simulation to model the physics of flow and contaminant transport in complex settings or the mechanics of immiscible fluids in porous media. QP: CE 821 QA: CE 921

929. Selected Topics in Hydraulics
Fall of odd-numbered years. 1 to 3 credits.
A student may earn a maximum of 6 credits in all enrollments for this course. P: CE 826 or CE 828 or CE 829. Advanced fluid mechanics and hydraulics related to civil and environmental engineering.

999. Doctoral Dissertation Research Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 72 credits in all enrollments for this course.

QA: CE 999

CLASSICAL STUDIES CLA

Department of Romance and Classical Languages College of Arts and Letters

120. English from Latin and Greek Roots

Fall of odd-numbered years. 3(3-0)
Prefixes, suffixes, and roots of English vocabulary
from Greek and Latin word elements. QA: CLA 220

121. Medical Terminology
Spring of odd-numbered years. 3(3-0)
Basic Greek and Latin word elements used in the formation of prefixes, suffixes, and roots. QA: CLA 221

Greek Civilization

Fall. 3(3-0)

R. Not open to freshmen. Political, social, religious, and intellectual life of ancient Greece from the Mycenaean period to the death of Alexander the Great, through such authors as Homer, Herodotus, Aeschylus, Euripides, Aristophanes, Thucydides, and Plato.

QA: CLA 326

310. Roman Civilization

Spring. 3(3-0)

R: Not open to freshmen. Enduring features of Roman civilization to Justinian. Political institutions, religion, architecture, literary forms, creative arts, and gender roles. QA: CLA 327

Greek and Roman Literature in 350. English Translation

Fall. 3(3-0)

R: Not open to freshmen. Representative works of major Greek and Roman

QA: CLA 304, CLA 305