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 students.

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 doctoral students in Chemistry and Chemical Physics.

CHINESE   CHS

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

101. **Elementary Chinese I**
Fall. 5(5-0)
Pronunciation, writing system, and basic vocabulary and sentence patterns, with emphasis on conversation.

102. **Elementary Chinese II**
Spring. 5(5-0)
P: CHS 101 or approval of department.
Further work on conversation, character writing, and comprehension, with increasing emphasis on vocabulary building and grammar.

201. **Second-Year Chinese I**
Fall. 5(5-1)
P: CHS 102 or approval of department.
Intermediate-level work on skills in conversation, comprehension, and grammar. Practice in composition.

202. **Second-Year Chinese II**
Spring. 5(5-0)
P: CHS 201 or approval of department.
Further intermediate-level work on skills in conversation, comprehension, and grammar. Continued practice in composition.

301. **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.

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.

350. **Studies in the Chinese Language**
Spring. 3(3-0)
P: CHS 201 or approval of department.
Grammatical structures of modern Chinese. Grammar review, sound system, word formation, sentence and discourse structures, historical evolution of the Chinese language, dialects, sociolinguistics.

401. **Fourth-Year Chinese I**
Fall. 3(3-0)
P: CHS 302.
Reading, discussion, and writing of advanced materials, including classical texts of broad cultural interest.

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.

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 paper.

CIVIL ENGINEERING   CE

Department of Civil and Environmental Engineering
College of Engineering

271. **Engineering Surveying**
Fall. 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.

280. **Introduction to Environmental Engineering**
Fall, Spring. 3(3-0)
P: CEM 141 or CEM 151, MTH 132, CPS 101 or CPS 131.
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 pollution.

305. **Structural Analysis**
Fall, Spring. 3(3-0)
P: MSM 211. 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.

312. **Soil Mechanics**
Fall, Spring. 3(2-3)
P: MSM 211. R: Open only to Civil Engineering and Biosystems Engineering majors. Completion of Tier 1 writing requirement.
Engineering properties of soil and their measurement. Effective-stress concept. Permeability and seepage. Compaction. Consolidation, shear strength and stress-strain behavior.

321. **Introduction to Fluid Mechanics**
Fall, Spring. 4(3-2)
P: MTH 235 or concurrently. R: Open only to Civil Engineering and Biosystems Engineering majors. Completion of Tier I writing requirement. 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.

337. **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 production mix design.

400. **Structural Mechanics**
Fall. 3(3-0)
P: CE 305. 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.

405. **Design of Steel Structures**
Fall. 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.

406. **Design of Concrete Structures**
Spring. 3(3-0)
P: CE 305, CE 337. R: Open only to Civil Engineering majors.
Design of reinforced concrete beams, slabs, columns and footings.

418. **Geotechnical Engineering**
Fall. 4(4-0)
P: CE 312. 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.

421. **Engineering Hydrology**
Fall. 3(3-0)
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 development, well flows.

422. **Applied Hydraulics**
Spring. 3(2-2)
P: CE 321 or ME 332. R: Open only to Civil Engineering, Mechanical Engineering, and Biosystems 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.

431. **Pavement Design and Analysis I**
Fall. 4(4-0)
P: CE 312, CE 337. R: Open only to Civil Engineering majors.
Highway and airfield pavement structural design. Performance measures. Failure mechanisms, popular thickness design procedures, and design considerations for surface friction, pavement joints, and drainage. Design of rehabilitation alternatives, design of overlays.

441. **Highway Operations**
Fall. 3(3-0)
P: STT 351. R: Open only to Civil Engineering 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.

442. **Airport Planning and Design**
Fall. 3(3-0)
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.

443. **Advanced Airport Systems Design**
Spring. 3(3-0)
P: CE 442. R: Open only to Civil Engineering majors.
Analysis and design of airport systems using computer models. Design parameters, demand analysis. Runway orientation and capacity, airside delay, vehicle processing. Passenger processing.
SA: CE 842

448. **Transportation Planning**
Spring. 3(3-0)
P: STT 351. R: Open only to Civil Engineering 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.

449. **Highway Design**
Fall, Spring. 4(3-3)
P: CE 271. R: Open only to Civil Engineering majors.
Geometric design of highways as related to operation, capacity and safety. Alignment, drainage and pavement design. The use of CAD systems in preparing contract plans.

480. **Water and Wastewater Analysis Laboratory**
Fall. 1 credit.
C: CE 481 concurrently. R: Open only to majors in Civil Engineering and Environmental Engineering.
Chemical and microbial analysis of water and wastewater.

481. **Environmental Engineering Chemistry**
Fall. 3(3-0)
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 wastewater.

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.

485. **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.

487. **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.

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.

491. **Civil Engineering Design Project**
Fall, Spring. 1 to 4 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.
Planning, specification, and design of a civil engineering project or facility.

801. **Experimental Methods for Structures and Materials**
Spring of odd-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.

802. **Introduction to Dynamics and Earthquake Engineering**
Fall. 2 credits.
P: MSM 306. R: Not open to students with credit in ME 461.
Dynamic response of single degree-of-freedom systems. Damping in structures and soils. Time domain and frequency domain methods. Analytical and numerical solution techniques. Earthquake response spectra.

803. **Dynamics of Structures and Soils and Earthquake Engineering (MTC)**
Fall. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course.
C: CE 802 concurrently.
Topics vary each semester. Topics such as structural dynamics, soil dynamics, and earthquake engineering.

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.

805. **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.

806. **Advanced Concrete Materials and Structures**
Spring of odd-numbered years. 3(3-0)
P: CE 406
Analysis and design of indeterminate reinforced concrete structural systems. Seismic design of reinforced concrete structures. Modeling of elastic, viscoelastic, fracture properties and concrete materials.

807. **Concrete Materials and Technology**
Summer. 3(3-0)
Concrete properties and production, structure-property relations. Advances in concrete technology. Special engineering applications.

808. **Prestressed and Fibrous Concrete**
Fall of even-numbered years. 3(3-0)
P: CE 406
Analysis and design of prestressed concrete structures. Production and properties of fiber reinforced concrete. Theory, design and testing of fibrous concrete.
SA: CE 906

809. **Finite Element Method**
Fall, Spring. 3 credits. Interdepartmental with Materials Science and Mechanics, Biosystems Engineering, and Mechanical Engineering. Administered by Materials Science and Mechanics.
Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics, and stress analysis.

810. **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.

811. **Advanced Hydrogeology**
Spring. 3 credits. Interdepartmental with Geological Sciences. Administered by Geological Sciences.
P: CE 821
Processes influencing groundwater flow and solute transport. Mathematical equations and numerical methods to describe these processes.

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.

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.

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.

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.

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.

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.

828. **Free Surface Flow**
Spring of odd-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.

829. **Fluid Transients**
Spring of odd-numbered years. 3(3-0)
Application of unsteady flow concepts and wave mechanics to hydraulic engineering: method of characteristics, surges and water hammer in piping systems, resonance phenomena.

831. **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.

835. **Engineering Management of Pavement Networks**
Spring of even-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 engineering actions.

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.

838.   Selected Topics in Highway and
        Airfield Engineering
        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 nondestructive 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.

839.   Stabilizing Unbound Granular
        Materials
        Fall of even-numbered years. 3(3-0)
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.

840.   Plates and Shells
        Fall of even-numbered years. 3(3-0) Interdepartmental with Materials Science and Mechanics. Administered by Materials Science and Mechanics.
P: MSM 815.
Deformation and stress analysis of plates and shells with different types of geometry, thickness, and boundary conditions.

841.   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 systems.

843.   Simulation and Optimization of 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 optim ization.

844.   Highway and Traffic Safety
        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 manage ment.

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.

846.   Statewide Transportation Network
        Evaluation
        Spring of odd-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.

848.   Travel Demand Analysis
        Fall 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.

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.

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 only to Civil Engineering master's students. 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. 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.

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.

902.   Random Vibration of Structural and
        Mechanical Systems
        Spring of odd-numbered years. 3(3-0) Interdepartmental with Mechanical Engineering and Materials Science and Mechanics.
P: CE 802 or ME 860; CE 810.
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 nonlinea r problems.

904.   Advanced Structural Mechanics II
        Spring. 3(3-0)
P: CE 804.
Complementary energy, hybrid finite element, applications of plasticity theory. Nonlinear analysis of frames. Nonlinear finite elements. Computer implementation.

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.

921.   Advanced Topics in Groundwater
        Spring of odd-numbered years. 3(3-0)
P: CE 821.
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.

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.

990.   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 Civil Engineering doctoral students
Research problems of limited scope not pertaining to thesis accomplished under CE 999.

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.

CLASSICAL STUDIES   CLA

Department of Romance and
Classical Languages
College of Arts and Letters

120.   Latin and Greek Roots of English Words
        Spring of even-numbered years. 3(3-0)
Prefixes, suffixes, and roots of English vocabulary from Greek and Latin word elements.

210.   Greek Civilization
        Fall. 3(3-0)
General survey of salient aspects of ancient Greek civilization and modern approaches to its study.

211.   Roman Civilization
        Spring. 3(3-0)
Ancient Roman civilizations and modern approaches to their study.
SA: CLA 310

292.   Introduction to Ancient Studies
        Fall. 2(1-2) Interdepartmental with Arts and Letters, History, and History of Art. Administered by Arts and Letters.
Methods and current trends in the study of the Greek and Roman world. Visits to library and museum collections.

350.   Greek and Roman Literature in
        English Translation
        Fall of even-numbered years. 3(3-0)
R: Not open to freshmen.
Representative works of major Greek and Roman authors.

360.   Ancient Novel in English Translation
        Spring of odd-numbered years. 3(3-0)
R: Not open to freshmen.
Translation of the ancient Greek and Roman novel. Interpretation of assigned novels. The role of popular literature in Greco-Roman society.

400.   Women in Classical Greek Society
        Spring of odd-numbered years. 3(3-0) Interdepartmental with Women's Studies.
R: Not open to freshmen and sophomores.
Image, role, and status of women in Greek society as seen through literary sources.

491.   Topics in Classical Studies
        Spring of even-numbered years. 3(3-0)
P: CLA 210. R: Open only to juniors and seniors.
Special topics supplement regular course offerings.

499.   Senior Thesis
        Fall, Spring. 3(3-0)
P: LTN 402. R: Approval of department.
Scholarly research and writing with a focus on specific problems, under faculty supervision.