880. Atomic and Molecular Structure
Fall. 3(3-0) 462 or approval of department.
Basic concepts of non-relativistic quantum mechanics will be developed and employed in a description of atomic and molecular structure.

881. Thermodynamics
Winter. 3(3-0) Approval of department.
Laws of thermodynamics and their application to pure substances and solutions.

883. Chemical Kinetics
Spring. 3(3-0) 880.
Rates and mechanisms of chemical reactions, reaction rate theory, kinetic theory of gases, photochemistry.

890. Problems and Reports
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 12 credits. Approval of department.

899. Research
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 12 credits. Approval of department. Research in inorganic, analytical, organic, and physical chemistry.

908. Seminar
Summer. 2 credits. Approval of department.
Topics are selected from current active research areas.

913. Selected Topics in Inorganic Chemistry
Fall, Spring. 3(3-0) May re-enroll for a maximum of 9 credits if different topic is taken.
Rare earth elements, recent advances in the chemistry of metals or nonmetals, high-temperature chemistry, Coordination chemistry and non-aqueous solvents.

918. Seminar in Inorganic Chemistry
Fall, Winter, Spring. 0 or 1(1-0)
Discussions of recent advances and reports by graduate students on research problems.

924. Selected Topics in Analytical Chemistry
Fall, Winter, Spring. 2(2-0) May re-enroll for a maximum of 6 credits if different topic is taken.
Among topics which may be discussed are: advances in electro-analytical chemistry or spectroscopy; non-aqueous solvents in analytical chemistry; theory of acid-base and complexation equilibria.

938. Seminar in Analytical Chemistry
Fall, Winter, Spring. 0 or 1(1-0)
Discussions of recent advances and reports by graduate students on research problems.

956. Selected Topics in Organic Chemistry
Fall, Winter, Spring. 2(2-0) or 3(3-0) May re-enroll for a maximum of 12 credits if different topic is taken. Approval of department.
Topics may be selected from heterocycle chemistry, natural products, free radicals, carbonium ions, organic sulfur or nitrogen compounds, acidity functions, isotope effects, photochemistry and others.

959. Seminar in Organic Chemistry
Fall, Winter, Spring. 0 or 1(1-0)
Discussions of recent advances and reports by graduate students on research problems.

985. Statistical Thermodynamics
Fall of odd-numbered years, Winter and Spring of even-numbered years. 3(3-0) May re-enroll for a maximum of 9 credits if different topic is taken. Approval of department.
Definition of partition function; translational, rotational, vibrational and electronic partition functions and their calculation and application to thermodynamic problems; application of statistical mechanics to thermodynamic calculations.

987. Selected Topics in Physical Chemistry
Fall. 3(3-0) May re-enroll for a maximum of 6 credits if different topic is taken. Approval of department.
Mathematical preparation for quantum chemistry. Selected topics as: kinetics and photochemistry, macromolecular and surface chemistry, molecular spectroscopy, electron and magnetic properties of matter, application of statistical mechanics to chemical problems.

988. Selected Topics in Physical Chemistry
Winter. 3(3-0) May re-enroll for a maximum of 9 credits if different topic is taken. Approval of department.
Topics may be chosen from analysis and interpretation of the spectra of molecules, advanced molecular structure, magnetic resonance, spectroscopy, X-rays and crystal structure, statistical mechanics.

991. Quantum Chemistry
Fall, Winter, Spring. 3(3-0) May re-enroll for a maximum of 9 credits if different topic is taken. Approval of department.
Principles of quantum chemistry and their application to chemical problems. Electronic structure of molecules and its correlation with the chemical and physical properties of substances. Excitation and absorption of radiation.

999. Seminar in Physical Chemistry
Fall, Winter, Spring. 0 or 1(1-0)
Discussions of recent advances and reports by graduate students on research problems.

999. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Research in analytical, inorganic, organic, and physical chemistry.

CHINESE
See Linguistics and Oriental and African Languages.

CIVIL AND SANITARY ENGINEERING
College of Engineering

Civil Engineering

C E

251. Elementary Surveying
Fall, Spring. 4(3-3) Trigonometry, EGR 100 or 267. Not open to majors.
Use of the tape, compass, level, and transit with simple maps, traverse closures and area computations. Profile, cross section and stadia surveys, U.S. land system.

252. Surveying I
Fall, Spring. 5(4-3) Trigonometry. Instruments, theory of measurements, error analysis, stadia, horizontal and vertical curves, U.S. Public Land Survey, observation for meridian.

305. Structural Mechanics I
Winter. 4(3-0) MME 211. Stability and determinacy of structures. Two and three dimensional determinate structures. Indeterminate structural analysis by displacement and force methods based upon equilibrium, compatibility and load-deformation relations.

308. Engineering Materials I
Winter. Spring. 4(3-3) MME 211 or concurrently.
Structure; composition; physical, mechanical and rheological properties of non-metallic construction materials. Emphasis on aggregates, asphalt, inorganic cements, concrete, and wood.

311. Urban Utilities
Winter. 3(3-0)
Capacities, limitations, and cost of public and semi-public utilities that they relate to the planning and design of the urban environment. Topics include transportation, water supply, storm drainage, sewage collection and treatment, solid waste and municipal finance.

312. Soil Mechanics I
Spring. Summer. 4(3-3) MME 211.
Properties of soil and particulate materials, physics of clay water systems, effective stress and consolidation theory, soil strength theory, and introduction to problems of design and construction.

321. Hydrodynamics
Winter. Spring. 5(4-3) MME 206.
Fundamentals of flow of real fluid, fluid properties, kinematics, continuity, laminar and turbulent flow, form drag, stream lines, potential flow pipe and open channel flow.

342. Survey of Transportation Systems
Fall. 4(4-0) Juniors, not open to majors.
Survey of engineering aspects of all forms of transportation with emphasis on highway transportation including highway systems, planning, economic and financial aspects, geometries and traffic studies.

346. Transportation
(448) Fall. 3(3-0) MTH 214
Planning, design and evaluation of transportation systems. Operational characteristics of transportation modal, traffic flow and techniques for system selection.

347. Transportation Facilities
(447) Winter. 4(3-3) 215 or 252.
Geometric design of highway and airport facilities as these considerations affect capacity, traffic control and economics of transport systems. Financing and administration of transport systems.

353. Surveying II
Fall, Spring. 4(3-3) 251 or 252.
Combination of 252 including photogrammetric methods, astronomical for latitude, longitude and meridian. Introduction to geodetic methods.
421. Hydrology
Fall, 3(3-0) MTH 112.
Formulation of engineering decisions governed by current and future costs and returns. Comparison and optimization of alternative engineering projects, products and processes.

422. Hydraulics
Spring, 4(3-2) 321.
Pipes and pipe networks, open channel flow, flow measurements, hydraulic machinery, surges and water hammer.

445. Transportation Planning
Winter, 3(3-0) 342 or 346.
Urban transportation facilities needs and programs. Design of transportation models for urban highways and public transit including trip generation, trip distribution, mode split and traffic assignment. Transport agencies function and services.

449. Highway Engineering
Spring, 3(2-0) 385, 387.
Design concepts of roadways, facilities, drainage and pavement design. Maintenance, construction and supervision methods and procedures.

451. Scheduling Construction Activities
Winter. 3(2-1) 381; CEM 131 or 141.
Techniques for coordinating and controlling construction projects. Scheduling under the constraints of deadlines, uncertain time estimates and limited resources. Computer programs and files for effective management.

483. Environmental Engineering II—Water Pollution and Pollution Control
Fall, 4(3-2) 381; CEM 131 or 141.
Environmental contamination. Parameters of air and water pollution. Storm and waste water collection systems. Physical, chemical and biological treatment of waste water.

487. Environmental Engineering III—Water and Waste Water Analysis
Winter. 4(3-3) 493.

499. Civil Engineering Projects
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 6 credits. Approval of department.
Original civil engineering problem of specific interest to the student and a faculty member. Student's proposal describing problem required prior to approval.

800. Operations Research Techniques for Civil Engineers
Fall, 3(3-0) Graduate standing.
Elements of deterministic methods of operations research with emphasis on computational techniques and applications to civil engineering problems such as structural design, water supply, transportation, and construction management.

802. Structural Dynamics I
Winter. 3(3-0) 405, 406, or approval of department.
Basic concepts in structural dynamics; dynamic loading on structures due to blasts and earthquakes; dynamic properties of structures; methods of analysis; design approach to blast and earthquake resistant structures; dynamic behavior of bridges and other topics.

803. Structural Dynamics II
Spring. 3(3-0) 502.

804. Advanced Structural Theory I
Winter. 4(4-0) 500, or approval of department.

805. Advanced Theory of Reinforced Concrete I
Winter. 3(3-0) 600.
Deflection, torsion, shrinkage, plastic flow, and ultimate strength of concrete structures. Prestressed concrete.

807. Model Analysis
Fall. 3(3-2) 408.
Basic theory of the analysis of structures by means of models. Laboratory work on models. Begg's deformeter and electric resistance type gauges for the measurement of static and dynamic strains.

815. Principles of Highway and Airport Soils
Winter. 4(4-0) 347.
Foundations problems as related to highways and airports, relation of subgrade conditions to design and construction, analytical review of laboratory and field results.

817. Mechanical Properties of Soils
Fall. 4(3-3) 419 or approval of department.
Mechanical properties of soil including stress-strain behavior; conditions of failure and shear strength; consolidation theory and permeability. Laboratory determination of soil properties including interpretation of experimental data for use in practice.

818. Advanced Soil Mechanics
Winter. 4(4-0) 419; 817 recommended.
Elastic and plastic equilibrium in soil masses, earth pressure and bearing capacity theories.

821. Flow of Fluids in Porous Media
Spring. 3(3-0) 422.

828. Hydraulic Engineering I
Fall, 3(3-0) 422.
Application of hydromechanics to hydraulic engineering; open channel flow, uniform flow and gradually varied flow, flood routing; supercritical flow in steep chutes, bends and transitions; hydraulic jump and structures for the dissipation of energy.

829. Hydraulic Engineering II
Winter. 3(3-0) 528.
Continuation of applications of hydromechanics to hydraulic engineering problems: subcritical flow in channel transitions and controls, spillways, gates, contractions, expansions, culverts; flow measurements; model studies, similitude, construction and instrumentation of models, interpretation and limitations of models.
843. Traffic Engineering
Characteristics
Winter. 3(3-0) 346. STF 431.
Safety analyses, flow and capacity characteristics, statistical properties of traffic, queuing characteristics at intersections, delay characteristics and analyses.

844. Traffic Engineering Theory and Control
Spring. 3(3-0) 843.
Application of the theory of traffic flow to the design and control of traffic streams. Dispatching, school bus and network analysis. Application to highways, airport operation and urban transportation modal.

846. Highway Planning
Fall. 3(3-0) 349 or approval of department.
Highway inventory, road use studies and programming, analysis of highway costs, economic considerations in location and design.

847. Geometric Design of Highways
Winter. 3(3-0) 346 or approval of department.
Design of streets and highways including intersections, parking facilities, capacity, channelization and roadway appurtenances.

848. Transportation Models
Spring. 3(3-0) 448.
Analysis of transportation modeling process, including error propagation and parameter sensitivity analysis. Comparative attributes of zonal size and model sequence decisions on the evaluation of system alternatives.

850. Special Problems in Civil Engineering
Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Research problems of limited scope not pertaining to thesis accomplished under 899 or 999.

859. Research
(EGR 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

903. Treatment of Industrial Wastes
Spring. 3(3-0) 405.
Continuation of 405 with application of theory to analysis and design of tanks, rigid frames, and shells.

905. Advanced Theory and Design of Reinforced Concrete II
Spring. 3(3-0) 406.
Analysis and design of multiple-story building frames, continuous trusses and rigid-frame girder bridges in structural steel. Plastic design.

999. Research
(EGR 999.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

CLASSICAL STUDIES
See Romance Languages

COMMUNICATION

COM
College of Communication Arts

100. Human Communication I
Fall, Winter, Spring, Summer. 3(3-0)
Process and functions of communication. Principles underlying communication behavior. Practice in analyzing communication situations and in speaking and writing.

101. Human Communication II
Fall, Winter, Spring, Summer. 3(3-0)
Continuation of 100, with greater emphasis on speaking and writing, and on analyzing increasingly complex communication situations.

102. Persuasion
(395, S T 305.) Fall, Winter, Spring. 4(4-0) 101.
Process of influencing human behavior through persuasive communication. Experience in creating persuasive messages and in evaluating the acceptability of persuasive attempts.

210. Leadership
(116, S T 116.) Fall, Winter. 4(4-0) 109.
Principles and practice in the utilization of communication for effective leadership.

299. Individual Projects
Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 15 credits. 199, approval of project proposal by department.
Independent research, experience in communication laboratories, or tutorial work in communication skills.

300. Effects of Communication I
Fall, Winter, Spring, Summer. 4(4-0) 100; majors must enroll in 300R concurrently. Examination of the dimensions of communication effects.

300R. Effects of Communication II
Fall, Winter, Spring, Summer. 1 credit. 100; majors must enroll in 350R concurrently.
In-depth consideration of effects of communication.

315. Organizational Communication
(311, S T 311.) Spring. 4(4-0) 101.
Principles and practice in the management of communication systems, with emphasis on conflict resolution, information exchange, innovativeness, and information management.

350. Signs and Sign-Behavior I
Fall, Winter, Spring, Summer. 4(4-0) 100; majors must enroll in 450R concurrently. Theories of man's symbolic behaviors. Semiotics and general semantics.