987. Selected Topics in Physical Chemistry  
Fall, Winter. 3(3-0) May reenroll for a maximum of 9 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, electro and magnetic properties of matter, application of statistical mechanics to chemical problems.

988. Selected Topics in Physical Chemistry  
Winter, Spring. 3(3-0) May reenroll 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. Selected Topics in Quantum Chemistry  
Fall, Winter. 3(3-0) May reenroll for a maximum of 9 credits if different topic is taken. Approval of department.  
Principles of quantum mechanics and application to chemical problems. Selected topics from spectroscopy, properties of atoms and molecules in electric and magnetic fields, and theories of molecular electronic structure.

998. Seminar in Physical Chemistry  
Fall, Winter, Spring. 1(1-0) May reenroll for a maximum of 3 credits. Discussions of recent advances and reports by graduate students on research problems.

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

CHINESE

See Linguistics and Germanic, Slavic, Asian and African Languages.

CIVIL AND SANITARY ENGINEERING

College of Engineering

Civil Engineering

251. Elementary Surveying  
Fall, Spring. 3(3-0) Not open to majors.  
Use of the tape, compass, level, and transit with emphasis on topographic and land area computations. Profile, cross section and stadia surveys, U.S. land system.

252. Surveying I  
Fall, Spring. 3(3-0) Engineering majors or approval of department.  
Instruments, theory of measurements, error analysis, stadia, horizontal and vertical curves, U.S. Public Land System, observation for meridian.

280. Introduction to Environmental Engineering  
Fall, Winter, Spring. 4(4-0) C E 141, or C E 151, MTH 112, CPS 120.  
Hydrology; ground water and surface water supply systems; wastewater treatment, methods of pollution control for solid waste, air, and noise.

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

306. Engineering Materials I  
Fall, Winter, Spring. 3(3-3) M M 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 of odd-numbered years. 3(3-0)  
Capacities, limitations and cost of public and semi-public utilities as 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  
Winter, Spring, Summer. 4(3-3) M M 211.  
Engineering properties of soils and their measurement. Effective stress concept; permeability; fluid flow in soils; stress-strain behavior; soil strength; consolidation and consolidation of soils; field exploration and design problems.

321. Introductory Fluid Mechanics  
Fall, Winter, Spring. 5(4-3) M M 306.  
Fluid properties; hydrostatics; control volume approach to conservation of mass, momentum and energy; dimensional analysis and dynamic simulation; fluid resistance; pipe and open channel flows; boundary layer concepts.

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, geometrics and traffic studies.

346. Transportation  
Winter, Spring, Summer. 3(3-0) M T H 113.  
Planning, design and evaluation of transportation systems. Operational characteristics of transportation modes, traffic flow and techniques for system selection.

405. Structural Design in Steel  
Fall, Winter. 4(4-0) C E 305, C E 390.  
Beams, columns, tension and compression members, connections. Elastic, plastic and ultimate strength concepts.

405. Structural Design in Concrete  
Winter. 4(4-0) C E 305, C E 308, C E 390.  

407. Structural Design Concepts  
Spring. 3(3-0) C E 405, C E 406.  
Develop and expand design concepts through study, investigation and project design of various structural systems; criteria for material selection and creative design of unusual structural systems pursued.

410. Structural Mechanics III  
Winter. 4(4-0) C E 400, CPS 120.  
Continuation of C E 400. Matrix analysis of framed structures. Introduction to inelastic behavior of structures. Use of programmed computer solution techniques.

419. Soil Mechanics II  
Fall, Spring. 4(4-0) C E 312, C E 390.  
Foundation engineering. In situ consolidation, and secondary settlements; stress distribution in soil masses; lateral earth pressures on structures; bearing capacity of shallow foundations; introduction to stability analysis of earth structures.

421. Hydrology  
Spring. 4(3-2) C E 280, C E 321, C E 360.  
Engineering hydrology; frequency and precipitation analysis; streamflow analysis and the unit hydrograph; flood prediction; run-off runoff correlations; urban hydrology.
422. Hydraulic Systems
   Fall, Winter, 4(3-2) C E 321, C E 390 or M E 352.
   Steady flow in pipe networks; open channel flow; turbomachinery; groundwater hydraulics; introduction to unsteady flows. Applications to water supply systems; aquifer analysis; sewage and water hammer.

441. Highway Operations
   Fall, 3(3-0) C E 346 or C E 342, C E 390.
   Driver and vehicle characteristics affecting traffic flow; traffic flow density, headway and speed measurements; signing and signal control for efficient intersection operation; parking characteristics and capacity analysis.

442. Airport Planning and Design
   Fall, Spring, 4(3-2) C E 346, C E 390.
   The planning and design of the components of the airport system including ground access facilities, aircraft characteristics, the air traffic control system, airport configuration, capacity analysis, management systems.

443. Transportation Planning
   Winter, 3(3-0) C E 342 or C E 346, C E 390.
   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(3-0) C E 308, C E 347, C E 390.
   Design concepts of roadways, facilities, drainage and pavement design. Maintenance, construction and supervision methods and procedures.

471. Scheduling Construction Activities
   Winter, 3 credits. Approval of department.
   Techniques for coordinating and controlling construction projects. Scheduling under the constraints of deadlines, uncertain time estimates and limited resources. Computer programs and data files for effective management.

481. Water and Wastewater Analysis
   Fall, 4(3-3) C E 280, C E 389.
   Quantitative analysis; bacteriologic and chemical characteristics of water and wastewater; principles of softening, iron removal, coagulation and chlorination; laboratory examination of water and wastewater including turbidity, solids, coliforms, chlorine, etc.

483. Water and Wastewater Treatment
   Spring, 4(3-2) C E 280, C E 422. Not open to graduate majors in sanitary engineering.
   Water treatment theory and design including sedimentation, coagulation, softening, iron removal and chlorination; wastewater treatment theory and design including grit chambers, activated sludge, trickling filter, and anaerobic digesters.

485. Environmental Health Engineering
   Winter, 4(3-2) MPH 200, C E 280, C E 321, C E 390.
   Design of small water, waste water and solid waste facilities. Epidemiology of communicable disease transmission by air, water, food and arthropods. Engineering measures to control disease spread.

494. Civil Engineering Design Project
   Fall, Winter, Spring, 3(2-2) M May reenroll for a maximum of 6 credits. Seniors, approval of department.
   Planning, specifications and design of a civil engineering project or facility.

499. Civil Engineering Projects
   Fall, Winter, Spring, Summer, 1 to 4 credits. May reenroll 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.

502. Structural Dynamics I
   Fall, 3(3-0) C E 405, C E 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.

504. Advanced Structural Theory I
   Winter, 4(4-0) C E 400, or approval of department.
   Energy principles and their application in the analysis of elastic structures, Advanced force and displacement methods and their matrix formulation. Introduction to finite element methods.

505. Advanced Theory of Reinforced Concrete I
   Winter, 3(3-0) C E 406.
   Deflection, torsion, shrinkage, plastic flow, and ultimate strength of concrete structures. Prestressed concrete.

507. Model Analysis
   Fall, 3(2-3) C E 406.
   Basic theory of the analysis of structures by means of models. Laboratory work on models; Begg's deformer and electric resistance type gauges for the measurement of static and dynamic strains.

509. Finite Element Method
   Fall, 4(4-0) Approval of department. Interdepartmental with the departments of Metallurgy, Mechanics, and Materials Science and Agricultural Engineering. Administered by the Department of Metallurgy, Mechanics, and Materials Science.
   Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics and stress analysis.

512. Rock Mechanics
   Fall of odd-numbered years, 3(3-0) MM 211; C E 312.

515. Principles of Highway and Airport Soils
   Fall, 4(4-0) C E 347.
   Foundation problems as related to highways and airports; relation of subsurface conditions to design and construction; analytical review of laboratory and field results.

817. Mechanical Properties of Soils
   Fall, 4(3-3) C E 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) C E 419; C E 817 recommended.
   Foundations and earth retaining structures; bearing capacity, lateral resistance and settlement of deep foundations; earth pressures on braced excavations and sheet pile walls; design of caissons and cofferdams.

819. Soil Stabilization in Geotechnical Engineering
   Summer, 3(3-0) C E 419.
   Techniques to improve the performance of soil in engineering applications; compaction, blending, admixture, grouting, electromechanics, vibration, compaction piles, thermal treatment, load bearing and hydraulic fills, precompression, reinforced earth.

820. Geotechnical Engineering for Cold Regions
   Spring, 3(3-0) C E 419 or approval of department.
   Physical and thermal properties of ice and frozen soil; ground thermal regime; mechanical properties of frozen ground; thaw consolidation problems; foundation design, slope stability problems, and artificial freezing for construction.

821. Flow of Fluids in Porous Media
   Fall, 4(4-0) C E 422 or approval of department.

827. Environmental Fluid Mechanics
   Spring of even-numbered years, 4(4-0) C E 422 or approval of department.
   Review of turbulent flow and transport processes in water quality control. Analysis and solution of ecological problems related to diffusion and disposal in rivers, estuaries, lakes and the ocean environment.

828. Open Channel Flow
   Winter, 3(3-0) C E 422 or approval of department.
   Fundamentals of free surface flow; steady uniform and nonuniform concepts; energy and momentum principles; subcritical and supercritical regimes; gradually and rapidly varied flow; design applications.

829. Fluid Transients
   Spring of odd-numbered years, 4(4-0) C E 828 or approval of department. Interdepartmental with the Department of Mechanical Engineering.
   Application of unsteady flow concepts and wave mechanics to hydraulic engineering: method of characteristics; surges and waterhammer in piping systems; unsteady open channel flow; oscillatory waves; similarity and models.
840. 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 C E 899 or C E 699.

899. Master's Thesis Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

A-50
924. **Air Sampling and Analysis**  
Spring of odd-numbered years. 4(3-3)  
SE 924.  
Theory and design of air sampling programs. Quantitative analysis of ambient air samples and stack samples. Analysis for sulfur oxides, nitrogen oxides and particulates.

999. **Doctoral Dissertation Research**  
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**CLASSICAL STUDIES**

See Romance and Classical Languages.

**COMMUNICATION COM**

College of Communication Arts and Sciences

100. **Human Communication**  
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.

115. **Oral Communication**  
Fall, Winter, Spring, Summer. 3(3-0). COM 100 or approval of department. Principles and practice in adapting to audiences, creating and structuring messages, and developing effective delivery of formal and informal speeches. Critical evaluation of speeches by instructor and peers.

125. **Interpersonal Communication**  
Fall, Winter, Spring, Summer. 3(3-0). COM 100.  
Develop students' abilities to become more effective, responsible participants in interpersonal communication relationships, with emphasis on relating communicatively with others.

199. **Methods of Inquiry**  
Fall, Winter, Spring, Summer. 3(3-0). COM 125.  
Major theoretic orientations toward communication. Primary tools of scholarly inquiry.

205. **Persuasion**  
Fall, Winter, Spring, Summer. 4(4-0) COM 205.  
Process of influencing human behavior through persuasive communication. Experience in creating persuasive messages and in evaluating the acceptability of persuasive attempts.

210. **Leadership and Group Communication**  
Fall, Winter, Spring, Summer. 4(4-0) COM 210.  
Principles and practice in the utilization of communication for effective leadership, with special emphasis on group communication.

250. **Argumentation**  
Fall, Winter, Spring. 4(4-0) COM 250.  
Development and use of arguments; recent perspectives in argumentation; rhetorical and empirical study of argumentative messages.

299. **Individual Projects**  
Fall, Winter, Spring, Summer. 1 to 15 credits. May reenroll for a maximum of 15 credits. COM 199, approval of project proposal by department.  
Independent research, experience in communication laboratories, or tutorial work in communication skills.

300. **The Effects of Mass Communication**  
Fall, Winter, Spring, Summer. 4(4-0).  
Major social effects of mass media on audience behavior. Political communication. Media effects on children. Message strategies producing attitude change. Interrelationship between mass media and interpersonal communication. Decision making in mass media.

315. **Organizational Communication**  
Fall, Winter, Spring, Summer. 4(4-0) COM 100.  
Principles and practice in the management of communication systems, with emphasis on conflict resolution, information exchange, innovativeness, and information management.

326. **Communication in Business**  
Fall, Winter, Spring, Summer. 4(4-0) Juniors.  
Study and analysis of business and industrial communication problems; extensive instruction and practice in writing.

350. **Signs and Sign-Behavior**  
Fall, Winter, Spring, Summer. 4(4-0) COM 100.  
Theories of symbolic behavior. Language structure and communicative functions.

352. **Nonverbal Communication**  
Fall. 4(4-0) COM 100.  
Major nonverbal communication codes and functions they perform. Codes: body movement, touch, physical appearance, paralanguage, use of space, time, artifacts. Opportunities to analyze nonverbal communication of self and others.

399. **Special Topics in Communication**  
Fall, Winter, Spring. 4(4-0) May reenroll for a maximum of 8 credits. Juniors.  
Contemporary issues in communication.

405. **Quantitative Strategies in Communication Research**  
Fall, Spring, 4(4-0) Seniors.  
Design and statistical strategies in communication research. Project design and evaluation schema. Basic data handling and presentation.

410. **Classroom Communication**  
Spring. 3(3-0) Majors and minors or approval of department.  
Classroom as a communication system with emphasis on operationalizing philosophies of education in the environment, teacher and student roles and styles, affective and cognitive interactions, methods of systematic observation.

411. **Directing the Debate and Forensic Program**  
Fall. 3(3-0) Majors and minors or approval of department.  
Principles of and practice in argumentation; methods of coaching debate and individual events and managing tournaments; observation of high school tournaments, practices, and student congress.

413. **Seminar in Communication Education**  
Winter, Summer. 4(4-0) ED 327.  
Philosophies of curricular and co-curricular programs in communication education. Internship experience in those programs.

425. **Communication Campaign Analysis**  
Fall. 4(4-0) COM 300 or approval of department.  
Design of persuasive and information campaigns. Techniques and strategies for analyzing and influencing mass audience. Principles and practice in constructing messages and selecting media. Political and public service campaign focus.

430. **Information and Technology**  
Winter. 4(4-0) COM 315 or approval of department.  
Concepts and principles of information and information technology, with emphasis on effects on organizational processes.

431. **Conflict in Communication**  
Winter. 4(4-0) COM 125 or approval of department.  
Elaboration of theories in conflict resolution; development of strategies to resolve conflict situations; personal analysis of communication patterns that can affect conflict.

450. **Critical Perspectives on Communication**  
(360.) Fall, Winter, Spring. 4(4-0) COM 100.  
Interdependence of communication and other societal factors, emphasizing criteria for ethical and social appropriateness.

475. **Relational Communication**  
Spring. 4(4-0) COM 125.  
Theories and current research on relational communication, including stages of relational communication development; verbal and nonverbal relational messages of intimacy, similarity, arousal, privacy and dominance; role of culture and context.

499. **Special Projects**  
Fall, Winter, Spring, Summer. 1 to 15 credits. May reenroll for a maximum of 15 credits. Approval of project proposal by department.  
Independent research, group research, student-directed group projects.

805. **Communication Research**  
Fall. 4(4-0) First year graduate majors.  
Communication research strategy and methodology. Scientific process, bases for derivation and verification of hypotheses, and basic methods of designing research in communication.

806. **Communication Research**  
Fall. 4(4-0) COM 805; second year graduate majors.  
Continuation of COM 805.

815. **Organizational Communication**  
Winter, Spring. 4(4-0)  
Structure and function of communication in organizations, with emphasis on concepts and principles needed for effective management of organizational communication processes.