Topics may be selected from heterocyclic chemistry, natural products, free radicals, carbonium ions, organic sulfur or nitrogen compounds, acidity functions, isotope effects, photochemistry and others.

958. 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 even-numbered years. Winter and Spring of odd-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 spectroscopic measurements to thermodynamic calculations.

987. Selected Topics in Physical Chemistry
Fall. 3(3-0) May re-enroll 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. 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. Emission and absorption of radiation.

998. 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

251. Elementary Surveying
Fall, Spring. 4(3-3) Trigonometry, ECR 160 or 267 or L A 123. 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 System, observation for meridian.

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

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

311. Urban Utilities
Winter. 3(3-0) 251.
Utilities and improvements necessary for urban populations. Course primarily designed for students in urban planning.

312. Soil Mechanics I
Spring, Summer. 4(3-3) MMM 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. Hydraulics
Winter, Spring. 5(4-3) MMM 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, geometry and traffic studies.

351. Applied Surveying and Mapping
Fall, Spring. 5(3-0) 251, not open to majors.
Horizontal and vertical curves; earthwork, contours, volumes, meridian determinations.

353. Surveying II
Fall, Spring. 4(3-3) or concurrently.
Survey of engineering aspects of all forms of transportation with emphasis on highway transportation including highway systems, planning, economic and financial aspects, geometry and traffic studies.

370. Cost and Optimization Engineering
Fall. 3(3-0) MTI 214 or concurrently.
Formulation of engineering decisions governed by current and future costs and returns. Comparison and optimization of alternative engineering projects, products and processes.

372. Engineering Estimating
Winter. 4(4-0) Juniors.
Construction planning and estimating with particular attention to methods involving cost of materials, labor, equipment and overhead on a project. Methods used in estimating engineering projects.

374. Construction Administration
Spring. 4(4-0) Juniors.
Emphasis on owner-engineering-contractor relationships, ethics and professional registration. Plans, specifications, contract proposals, bidding procedures, and contract performance. Introduction to methods for project planning and control including critical path method.

382. Environmental Engineering I—Hydrology and Water Supply
Spring, Summer. 4(3-2) 321; CEM 131 or 141.

390. Civil Engineering Analysis
Fall, Winter. 3(3-0) MTH 215.
Analysis of civil engineering problems by numerical and statistical methods. Approximate methods and error analysis. Application to computer use.

400. Structural Mechanics II
Spring, Summer. 4(4-0) 305.
Energy methods in static and dynamic structural analysis, including the principles of virtual displacements and virtual forces. Influence lines. Matrix analysis of structures, influence and stiffness coefficients. Computer facilities are used.

405. Structural Design in Steel
Fall. 4(4-0) 306.

410. Structural Mechanics III
Fall. 4(4-0) 406.

419. Soil Mechanics II
Fall. 4(4-0) 312.
Elastic and plastic equilibrium in soil and rock masses, concepts of stability and soil-structure interactions. Applications to earth structures, bearing capacity and earth pressure problems.

421. Hydrology
Fall. 3(3-0) MTI 112; Juniors or approval of department.
Meteorologic and hydrologic phenomena associated with the hydrologic cycle; precipitation, melting of snow and ice, streamflow, evaporation and water table movement; observational and analytical methods; river forecasting, design applications.

422. Hydraulics
Spring. 4(3-2) 321.
Pipes and pipe networks, open channel flow, flow measurements, hydraulic machinery, surge and water hammer.
446. Transportation
Winter. 4(4-0) MMM 208.

History, development and function of transportation. Operational control and characteristic system coordination. Geometries of design, traffic flow and patterns.

447. Highway Facilities
Spring. 3(2-3) 308.


483. Environmental Engineering II—Water Pollution and Pollution Control
Fall. 4(3-2) 321; CEM 131 or 141.

Environmental contamination. Parameters of air and water pollution. Storm and waste water collection, treatment, and biological treatment of waste water.

487. Environmental Engineering III—Water and Waste Water Analysis
Winter. 4(3-0) 483.


499. Civil Engineering Projects
Fall, Winter, Spring. 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(0-6). 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) 802.


804. Advanced Structural Theory I
Winter. 4(4-0) 400, or approval of department.


805. Advanced Theory of Reinforced Concrete I
Winter. 3(3-0) 406.

Deflection, torsion, shrinkage, plastic flow, and ultimate strength of concrete structures. Prestressed concrete.

807. Model Analysis
Fall. 3(2-3) 406.

Basic theory of the analysis of structures by means of models. Laboratory work on models. Begg's defleximeter and electric resistance type gauges for the measurement of static and dynamic strains.

815. Principles of Highway and Airport Soils
Winter. 4(4-0) 447.

Foundation problems as related to highways and airports, relation of subsoils to design and construction, analytical review of laboratory and field results.

817. Mechanical Properties of Soils
Fall. 4(3-2) 419 or approval of department.

Mechanical properties of soil including stress-strain behavior, conditions of failure and their strength; consolidation theory and permeability. Laboratory determination of soil properties including interpretation of experimental data for use in practice.

819. Advanced Soil Mechanics
Winter. 4(4-0) 419; 917 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.


829. 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 shallow channels, bends and transitions; hydraulic jump and structures for the dissipation of energy.

829. Hydraulic Engineering II
Winter. 3(3-0) 828.

Continuation of applications of hydromechanics to hydraulic engineering: sub-critical flow in channel transitions and controls, spillways, gates, contractions, expansions, culverts; flow measurement; model studies; similarity construction and instrumentation of models, interpretation and limitations of models.

843. Advanced Traffic Engineering
Spring. 3(0-0) 446 or approval of department.

Accident record studies, signs and signals, roadway and intersection design, traffic administration, traffic surveys and analysis.

846. Highway Planning
Fall. 3(3-0) 446 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) 449 or approval of department.

Design of streets and highways including intersections, parking facilities, capacity, channelization and roadway appurtenances.

871. Advanced Construction Practice
Winter. 3 credits. Approval of department.

Advanced problems involved in construction. Theoretical analysis and practical solutions commonly employed. Emphasis on heavy construction including caissons, piles, foundations, tunnels, dams, and bridge structure.

880. 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.

909. Research
(ECR 899.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

904. Advanced Structural Theory II
Spring. 4(4-0) 804 or approval of department.

Energy (variational) approach to formulation and solution of problems in structural mechanics: stresses, displacements and stability of continuum and structural elements. Approximation methods including Rayleigh-Ritz and finite element methods.

905. Advanced Theory and Design of Reinforced Concrete II
Spring. 3(3-0) 905.

Continuation of 902 with application of theory to analysis and design of tanks, rigid frames, and shells.

906. Advanced Structural Steel Design
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.

908. Numerical Methods in Structural Engineering
Winter. 3(3-0) 908.

Solution of mathematical equations by means of successive numerical approximations and the application of these numerical methods to structural problems.

909. Elastic Thin Shells
Spring. 4(4-0) 804 or MMB 915 or approval of department; MTH 421. Interdepartmental with the Metallurgy, Mechanics and Materials Science Department.

Elements of differential geometry, membrane theory of shells, Pucker's stress function, deformation and bending of shells of revolution and shallow shells.

912. Theory of Plates
Winter. 4(4-0) 804 or MMB 915 or approval of department; MTH 422. Interdepartmental with and administered by the Metallurgy, Mechanics and Materials Science Department.

Bending of thin elastic plates with various shapes and boundary conditions. Application of energy principles and approximate methods of solution: thick plates; large deflection theory; sandwich plates.

915. Advanced Soil Mechanics II
Spring. 3(3-0) 817.

Earth structures including natural and cut slopes, embankments and earth dams; mechanisms of flow slides, slope stability analysis and design problems; seepage problems including application of energy principles and approximate methods of solution; thick plates; large deflection theory; sandwich plates.

918. Advanced Soil Mechanics III
Summer. 3(3-0) 817.

Soil dynamics including design of foundations for machinery; effects of ground motion on earth slopes and earth dams; behavior of soil during transient and repeated loadings; and relation of soil properties to wave velocity.
Sanitary Engineering

803. **Treatment of Industrial Wastes**
   Fall, Winter, Spring, Summer. Variable credit. May re-enroll for a maximum of 15 credits. 190, approval of project proposal by department. Independent research, experience in communication laboratories, or tutorial work in communication skills.

805. **Water Treatment Principles**
   Winter. 3(3-0) C E 483.
   Chemical and physical principles of water treatment.

806. **Sewage Collection and Treatment**
   Spring. 3(3-0) C E 483.
   Chemical, physical and biological principles of sewage collection and treatment.

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

905. **Biological Principles of Sanitary Engineering I**
   Fall. 2(2-3) C E 483.
   Fundamental physical, chemical, and biological principles relating to the field of sanitary engineering.

906. **Biological Principles of Sanitary Engineering II**
   Winter. 3(2-2) 905.
   Fundamental physical, chemical, and biological principles relating to the field of sanitary engineering.

909. **Research**
   (EGR 909.) Fall, Winter, Spring, Summer. Variable credit. Approval of department.

**COMMUNICATION**

**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**
   (S T 161.) Fall, Winter, Spring, Summer. 3(3-0) 100.
   Continuation of 100, with greater emphasis on speaking and writing, and on analyzing increasingly complex communication situations.

199. **Methods of Inquiry**
   Fall, Winter, Spring, Summer. 3(3-0)
   Majors and minors only. 191.
   Major theoretic orientations toward communication. Primary tools of scholarly inquiry.

205. **Persuasion**
   (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**
   (S T 116.) Fall, Winter. 4(4-0) 100.
   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. 190, 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 COM 300R concurrently. Examination of the dimensions of communication effects.

300R. **Effects of Communication II**
   Fall, Winter, Spring, Summer. 1 credit.
   Majors: 300 concurrently.
   In-depth consideration of effects of communication.

315. **Organizational Communication**
   (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. 4(4-0) 100; majors must enroll in COM 350R concurrently.
   Theories of man's symbolic behaviors. Semiotics and general semantics.

350R. **Signs and Sign-Behavior II**
   Fall, Winter, Spring. 1 credit.
   Majors: 350 concurrently.
   In-depth consideration of signs and sign behavior.

351. **Message Analysis**
   (440.) Winter. 4(4-0) 350.
   Methods of describing messages and message codes, with emphasis on the content of information.

352. **Non-Verbal Communication**
   (320.) Spring. 4(4-0) 350.
   Continuation of 351, with emphasis on non-verbal codes: gesture, expression, time and space, light.

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

399. **Seminar**
   (400.) Fall, Winter, Spring. Summer. 4(4-0) 399.
   Contemporary issues in communication.

405. **Research in Communication Strategies and Styles**
   (S T 405.) Fall, Spring, Summer. 5(5-0) Summer. 500.
   Research literature in communication strategies and styles.

413. **Seminar in Communication Education**
   (S T 413.) Fall, Winter, Spring, Summer. 4(4-0) 436.
   Philosophies of curricular and co-curricular programs in communication education. Internship experience in those programs.

420. **Message Design**
   Winter. 4(4-0) 101.
   Principles and practice in message-media construction and selection.

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

805. **Communication Research**
   Fall. (S-3) 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**
   Winter. (S-4) 805.
   Continuation of 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.

820. **Communication Theory and Process**
   Fall, Summer. 3(3-0)
   Theoretic models of communication, with emphasis on the applications of communication theory to various professional communication areas.

821. **Mass Communication Theory and Research**
   (S 411.) Fall, Spring. 4(3-0)
   Current theories and research in mass communication.

822. **Interpersonal Communication**
   (S 420.) Winter, Summer. 4(3-0)
   Current theories and research in interpersonal communication, with emphasis on persuasion.

825. **Cross-Cultural Communication**
   (S 423.) Winter, Spring, Summer. 4(4-0)
   Role of communication in the economic, social and political development of less developed countries. Problems in communicating across cultural boundaries.

830. **Nonverbal Communication**
   Fall. 4(4-0)
   A review of theory and empirical research on nonverbal communication with implications for application.

850. **Seminar in Research Utilization**
   (950.) Winter, Summer. 4(3-0) May re-enroll for a maximum of 8 credits. Approval of department. Applications of communication research to professional practice in such areas as teaching, change agencies, information system management, etc.

870. **Communication and Change: The Diffusion of Ideas and Information**
   (470.) Fall, Spring. 4(4-0)
   Research traditions underlying the diffusion of ideas and information, and acceptance of innovation and change. Strategic principles for introduction of change through the use of communication.

890. **Special Problems**
   Fall, Winter, Spring, Summer. 1 to 6 credits. Approval of department. Special problems as arranged with instructor.