

**838. Instrumental Analysis—
Instrumentation**
Winter. 3(3-4) Approval of department.

Practice in design, construction and testing of typical apparatus employed in instrumental chemical analysis.

**844. Structural Elucidation by
Instrumental Methods**
Fall. 3(3-0) Approval of department.

A practical instrumental analysis course with the major emphasis on the interpretation of data rather than a detailed description of the instrumentation. The fundamental principles behind the various measurements will be discussed in a general way, and important instrumental limitations will be noted.

851. Organic Chemistry
Fall. 3(3-0) 353; 462 or approval of department.

Chemical principles will be illustrated through a coordinated presentation of examples from inorganic and organic chemistry. About half of the course will be devoted to bonding and stereochemistry, the remainder to reactive intermediates in chemical reactions and their reactivity patterns.

852. Organic Chemistry
Winter. 3(3-0) 851.

Continuation of 851.

853. Organic Chemistry
Spring. 3(3-0) 852.

Continuation of 852.

880. Atomic and Molecular Structure
(882.) 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) 462 or 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.

One of the following topics will be discussed: advances in electroanalytical chemistry, redox reactions, non-aqueous solvents in analytical chemistry, theory of acid-base equilibria, complex compounds in chemical analysis.

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 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 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. 984 or 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**
Winter. 2(2-0) or 3(3-0) May re-enroll for a maximum of 6 credits if different topic is taken. Approval of department.

Discussion on such topics as: kinetics and photochemistry, macromolecular and surface chemistry, application of statistical mechanics to chemical problems, molecular spectroscopy, electric and magnetic properties of matter.

**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 C E

251. Elementary Surveying
Fall, Spring. 4(3-3) Trigonometry, EGR 160 or 267 or L A 123. Not open to majors.

Use of the tape, compass, level, and transit with simple maps; traverse closure and area computations. Profile, cross section and stadia surveys, U. S. land system.

252. Surveying I
Fall, Spring. 5(4-3) Trigonometry.

Theory of measurements, calculations, error analysis and instruments. Methods and calculations of engineering work.

253. Surveying II
Fall, Spring. 4(3-3) 252.

Land surveys, U.S. land systems, astronomical observations, triangulation and photogrammetry.

305. Structural Mechanics I
Winter, Spring. 4(4-0) MMM 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) MMM 211 or concurrently.

Structure, composition, physical and rheological properties of non-metallic construction; materials. Applications to agglomerated, cementitious, polymeric and pavement materials.

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 flow in porous media and consolidation theory. Effective stress theory, pore water pressure and soil strength theories.

321. Hydrodynamics
Winter, Spring. 5(4-2) 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, geometrics and traffic studies.

351. Applied Surveying and Mapping
Fall, Spring. 5(3-6) 251, not open to majors.

Horizontal and vertical curves; earthwork, contours, volumes; meridian determinations.

370. Cost and Optimization Engineering

Fall. 3(3-0) MTH 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 estimates with particular attention to material, labor, and equipment costs, overhead, and profit.

374. Construction Administration
Spring. 4(4-0) Juniors.

Methods used in construction practice and administration. Analysis of equipment and related operations for engineering projects. Use of critical path techniques. Contracts and relationships of engineer, owner and contractor.

382. Environmental Engineering I—Hydrology and Water Supply

Spring, Summer. 4(3-2) 321; CEM 131 or 141.

Hydrology of ground and surface waters. Hydraulic networks. Water supply and distribution systems. Water quality, control and treatment.

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 Synthesis I
Winter. 4(3-2) 305.

Design and synthesis of structures. Beams, columns, tension and compression members. Emphasis on steel structures. Elastic, plastic and ultimate strength concepts.

406. Structural Synthesis II
Spring. 4(4-0) 400.

Design and synthesis of reinforced concrete structures by elastic, plastic and ultimate strength concepts. Prestressed and post-tensioning theory and design.

410. Structural Mechanics III
Fall. 4(4-0) 400.

Beam-columns, elastic buckling, thin-walled members. Elementary theory with special reference to structures. Elements of plates and shells. Introduction to inelastic behavior of structures.

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.

422. Hydraulics

Spring. 4(3-2) 321, 390.

Pipes and pipe networks, open channel flow, flow measurements, hydraulic machinery, surges and water hammer.

446. Transportation

Winter. 4(4-0) MMM 206.

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

447. Highway Facilities

Spring. 4(3-3) 308.

Highway and airport engineering. Theory and design of rigid and flexible pavements. Highway construction.

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 systems. Physical, chemical and biological treatment of waste water.

487. Environmental Engineering III—Water and Waste Water Analysis

Winter. 4(3-3) 483.

Theoretical aspects of water quality. Chemical and physical parameters. Water bacteriology. Qualitative and quantitative measurements of contamination. Biochemical oxygen demand.

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) 802.

Dynamics of large scale structural systems. Network formulation and numerical methods. Behavior under random disturbances. Characterization of and response to random disturbances and failure criteria.

804. Advanced Structural Theory I

Winter. 4(4-0) 400; MTH 421; or approval of department.

Extensive treatment of energy theorems, with linear and nonlinear applications. Advanced matrix force and matrix displacement methods, for problems of great complexity. Application to plane and space frames and continuous (e.g. aircraft) structures. Computer facilities are used.

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(1-6) 406.

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) 447.

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

817. Mechanical Properties of Soils

Fall. 4(3-3) 419.

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.

Structure and properties of porous media. Fluid flow in saturated and unsaturated media. Two-phase flow. Darcy's and Navier Stokes equations. Two-dimensional sink flow. Multiple sources and sinks. Potential theory and conformal mapping. Permeability in an anisotropic medium.

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) 828.

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

843. Advanced Traffic Engineering

Spring. 3(3-0) 447.

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

846. Highway Planning

Fall. 3(3-0) 447.

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) 447.

Design of streets and highways including inter-sections, 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.

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

904. Advanced Structural Theory II
Spring. 4(4-0) 804; MTH 422 or concurrently.

Energy (variational) approach to deriving and solving equations governing advanced problems in beam-columns, rings, buckling, plates, load diffusions, etc. Approximate solutions by Rayleigh-Ritz and related methods.

905. Advanced Theory and Design of Reinforced Concrete II
Spring. 3(2-3) 805.

Continuation of 805 with application of theory to analysis and design of tanks, rigid frames, and shells.

906. Advanced Structural Steel Design
Spring. 3(2-3) 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(2-3) 406.

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 MMM 815 or approval of department; MTH 421. Interdepartmental with the Metallurgy, Mechanics and Materials Science Department.

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

912. Theory of Plates
Winter. 4(4-0) 804 or MMM 815 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 applications including confined and unconfined flow of water through soils.

916. 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; stress-strain behavior of soil during transient and repeated loadings; and relation of soil properties to wave velocity.

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

Sanitary Engineering S E

803. Treatment of Industrial Wastes
Spring. 3(3-0) C E 483.

Physical, chemical and biological treatment methods for industrial wastes.

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. 3(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(2-3) 905.

Fundamental physical, chemical, and biological principles relating to the field of sanitary engineering.

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

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
(S T 101.) 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. 101.

Major theoretic orientations toward communication. Primary tools of scholarly inquiry.

205. Persuasion
(305., 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) 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. 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. Majors. 300 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 emphases 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 350R concurrently. Theories of man's symbolic behaviors. Semiotics and general semantics.

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

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

352. Message Analysis II
(320.) Spring. 4(4-0) 351. Continuation of 351, with emphasis on non-verbal codes: gesture, expression, time and space, light.

360. Critical Perspectives on Communication
Fall, Winter, Spring. 4(3-0) 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) Majors only. 360. Contemporary issues in communication.

405. Research in Communication Strategies and Styles
(S T 405.) Fall, Spring, Summer. 5(5-0) Seniors. 300. Research literature in communication strategies and styles.