589. Instrumental Analysis—Instrumentation
Winter. 3(2-4) Approval of department.
Practice in design, construction and testing of
typical apparatus employed in instrumental
chemical analysis.

594. Structural Elucidation by Instrumental Methods
Fall. 3(2-0) 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 dis­
cussed in a general way, and important instru­
mental limitations will be noted.

581. Organic Chemistry
Fall. 3(5-0) 453; 402 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
inter­mida­cies in chemical reactions and their
re­activity patterns.

582. Organic Chemistry
Winter. 3(3-0) 851.
Continuation of 851.

583. Organic Chemistry
Spring. 3(3-0) 852.
Continuation of 852.

580. Atomic and Molecular Structure
(882.) Fall. 3(3-0) 463 or approval of department.
Basic concepts of non-relativistic quantum
mechanics will be developed and employed in
a description of atomic and molecular structure.

581. Thermodynamics
Winter. 3(3-0) 462 or approval of department.
Laws of thermodynamics and their application
to pure substances and solutions.

583. Chemical Kinetics
Spring. 3(3-0) 860.
Rates and mechanisms of chemical reactions,
reaction rate theory, kinetic theory of gases,
photochemistry.

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

599. 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.

913. Selected Topics in Inorganic Chemistry
Fall, Spring. 3(2-0) 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-tempera­
ture 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, com­
plex 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 Physical Chemistry
Fall, Winter, Spring. 2(2-0) or 3(3-0)
May re-enroll for a maximum of 6 credits if different topic is taken.
Approval of department.
Topics may be selected from heterocyclic chem­
istry, natural products, free radicals, carbonium
ions, organic sulfur or nitrogen compounds,
 acidity functions, isotope effects, photochem­
istry 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.

955. 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.
954 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.

975. 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.
Topics may be taken from such topics as:
kinetics and photochemistry, macromolecular
and surface chemistry, application of statistical
tools to chemical problems, molecular spectro­
scopy, and magnetic properties of matter.

978. 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 taken from such topics as:
kinetics and photochemistry, macromolecular
structure, magnetic resonance, spectroscopy,
X-rays and crystal structure, statistical
mechanics.

991. Quantum Chemistry
Fall, Winter, Spring. 3(2-0) May re-enroll
for a maximum of 9 credits if different topic is
taken.
Approval of department.
Principles of quantum chemistry and their appli­
cation to chemical problems. Electronic structure
of molecules and its correlation with the chem­
ical and physical properties of substances. Emis­
sion 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 180 or 267 or I. A. 183. 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 calcula­
tions 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 displace­
ment and force methods based upon equilib­
rium, compatibility and load-deformation rela­
tions.

308. Engineering Materials I
Winter, Spring. 4(3-3) MMM 211 or concurrently.
Structure, composition, physical and rheological
properties of non-metallic construction mater­i­
als. Applications to agglomerated, cementi­
ted, 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. 4(3-3) 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
theory.

321. Hydrodynamics
Winter, Spring. 5(4-2) MMM 206.
Fundamentals of flow of real fluid, fluid prop­
erties, kinematics, continuity, laminar and turb­
obulent 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.

351. Applied Surveying and Mapping
Fall, Spring. 5(3-6) 231, 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.

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. 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.

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.

419. Soil Mechanics II
Fall. 4(4-0) 312.
Elastic and plastic equilibrium in soil and rock

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) MTH 206.

447. Highway Facilities
Spring. 4(3-3) 385.

453. Environmental Engineering II—Water Pollution and Pollution Control
Fall. 4(3-2) 321; CEM 131 or 141.
Environmental examination. Parameters of air and water pollution. Storm and waste water collection systems. Physical, chemical and biological treatment of waste water.

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

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.

500. 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.

804. Advanced Structural Theory I
Winter. 4(4-0) MTH 493; 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 plate 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(3-0) 408.
Basic theory of the analysis of structures by means of models. Laboratory work on models. Begg's deflectioner and elastic resistance type gauges for the measurement of linear and dynamical 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(3-0) 419.
Mechanical properties of soil including stressstrain 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 channels, bends and transitions; hydraulic jump and structures for the dissipation of energy.

829. Hydraulic Engineering II
Winter. 3(3-0) 523.
Continuation of applications of hydromechanics to hydraulic engineering problems; sub-critical flow in channel transitions and controls, spillways, gates, contractions, expansions, culverts; flow measurements; model studies, similarity, 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, roadways 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 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.  

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 Structural Steel Design  
Spring. 3(2-3) 805.  
Analysis and design of multiple-story building frames, continuous trusses and rigid-frame girders in structural steel. Plastic design.  

906. Numerical Methods in Structural Engineering  
Winter. 3(2-3) 806.  
Solution of mathematical equations by means of successive numerical approximations and the application of these numerical methods to structural problems.  

907. Elastic Thin Shells  
Spring. 4(4-0) 804 or MMM 815 or approval of department; MTH 421. Inter-departmental 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 MMM 815 or approval of department; MTH 421. Inter-departmental 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 deformation 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  

503. Treatment of Industrial Wastes  
Spring. 3(3-0) C E 483.  
Physical, chemical and biological treatment methods for industrial wastes.  

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

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

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(2-0)  
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(2-0) 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 theoretical orientations toward communication. Primary tools of scholarly inquiry.  

205. Persuasion  
(F 605, 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 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. 100, approval of project proposal by department.  
Independent research, experience in communication laboratory, or tutorial work in communication skills.  

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

350. Signs and Sign-Behavior I  
Fall, Winter, Spring, Summer. 3(3-0) 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. 1 credit. Majors. 350 concurrently. In-depth consideration of effects of communication.  

315. Organizational Communication  
(S 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 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 effects of communication.  

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 nonverbal 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) 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.