

regulations, business organizations, bankruptcy, and property and related topics. (G)

441: Real Property. 0-3-3. Preq., BLAW 255. Estates in land, titles, deeds, mortgages, leases, land contracts, minerals, easements and successions.

445: Legal Aspects of Government and Business. 0-3-3. Preq., BLAW 255 or special permission of the instructor. A study of landmark law cases with special emphasis placed on guideline interpretive decisions of significance to management.

CHEMICAL ENGINEERING (CMEN)

202: Chemical Engineering Calculations. 3-2-3. Coreq., ENGR 122, MATH 242. Problems and recitation in material and heat balances involved in chemical processes. Application of Chemical Engineering and chemistry to manufacturing in chemical industries.

213: Unit Operations-Design I. 0-3-3. Preq., CMEN 202, 254, MATH 244. Design procedures for equipment and processes involving fluid flow and fluid mixing, with emphasis on computer assisted design techniques.

254: Laboratory Measurements and Report Writing. 3-0-1. Preq., CMEN 202 and completion of integrated freshman engineering curriculum. A study of applied analytical and statistical procedures and measurement of process variables in chemical processing and an introduction to technical report writing.

304: Transport Phenomena. 0-3-3. Preq., CMEN 213, 313, 413, MATH 245. Fundamental principles of energy, mass, and momentum transfer and transport processes.

313: Unit Operations-Design II. 0-3-3. Preq., CMEN 213 or consent of instructor. Design procedures for equipment and processes involving heat transfer, with emphasis on computer assisted design techniques.

332: Chemical Engineering Thermodynamics II. 0-3-3. Preq., ENGR 222. Estimation of thermodynamic properties from equations of state. Application of thermodynamic equilibria to physical and chemical equilibria. Energy analysis of processes.

353: Chemical Engineering Junior Laboratory. 3-0-1. Preq., CMEN 254, 313, and ENGL 303. Laboratory study of fluid phenomena, heat transfer processes and equipment, and evaporation.

402: Chemical Reaction Engineering. 0-3-3. Preq., CHEM 312; senior standing in CMEN. Homogeneous and heterogeneous chemical reaction kinetics, applications to ideal and real reactor types. (G)

407: Instrumentation and Automatic Process Control. 3-2-3 Preq., senior standing in CMEN. Survey of process instrumentation methods, and the analysis and design of feedback, feed forward, and cascade control systems. (G)

408: Pulp and Paper Processes. 0-3-3. Preq., senior standing in CMEN. Introduction to the pulp and paper industry, its terminology, technology and economics. Conversion of various cellulosic materials into unbleached pulp and paper products. (G)

411: Environmental Chemodynamics. 0-3-3. Preq., CMEN 413 and senior standing in CMEN. A study of the modeling and prediction of the movement and fate of synthetic chemicals in the air-water-earth environments. Cross-listed with CVEN 411. (G)

413: Unit Operations-Design III. 0-3-3. Preq., CMEN 313. Application of design procedures for equipment and processes involving evaporation, distillation, leaching, extraction, gas absorption and desorption, with emphasis on computer assisted design techniques.

415: Theory and Practice of Radiation Protection and Shielding. 0-3-3. Preq., senior standing. An introduction to principles of dosimetry. The concepts of probability of causation, risk assessment, and methods of establishing exposure limits will be discussed. (G)

430: Chemical Plant Design I. 0-2-2. Preq., senior standing in CMEN, ECON 215. An introduction to applied process economics and to process hazards, their identification and reduction.

432: Chemical Plant Design II. 0-2-2. Preq., senior standing in CMEN and CMEN 430. Comprehensive problems are assigned, the solution of which enables one to calculate dimensions and capacities of required plant equipment. Computer applications.

434: Chemical Plant Design III. 0-2-2. Preq., CMEN 432. CMEN 432 continued.

435: Polymer Engineering. 0-3-3. Preq., Senior standing in CMEN or consent of the instructor. Polymer technology and processes including polymer structure, states, and transitions; kinetics of polymerization; molecular weight determination; viscous flow; mechanical properties; polymer degradation; analysis and identification. (G)

442: Process Optimization. 0-3-3. Preq., senior standing in CMEN. An objective study of the present status of optimization methodology as

applied to the chemical process industries. Both deterministic and non-deterministic systems are considered. (G)

443: Air Pollution Control Design. 0-3-3. Preq., Senior standing in CMEN or consent of instructor. An overview of the air pollution problem. Design of devices to control emissions (VOC's, NO_x, SO₂, particulates, etc.) Cost estimation of air pollution control systems. (G)

450: Special Problems. 1-4 semester hours credit. Preq., senior standing in CMEN. Problems covering selected topics of current importance or special interest or need. (G)

451: Senior Chemical Engineering Laboratory. 6-0-2. Preq., CMEN 353 and 413 or consent of instructor. Laboratory work in humidification, drying, distillation, absorption, extraction, and kinetics.

452: Special Projects Laboratory. 1 hour credit. Preq., senior standing in CMEN. Selected comprehensive problems. Study and/or laboratory development of: industrial unit operations; new chemical processes; improvement of established processes; economic evaluations. Theoretical studies.

455: Biochemical Engineering. 0-3-3. Preq., CMEN 402 or consent of instructor. Introduction to biotechnology and bioprocesses. Microbiology and biochemical processes are reviewed. Enzyme kinetics, microbial growth transport phenomena, and design of biochemical reactors are studied. Cross-listed with BIEN 455. (G)

456: Hazardous Waste Management. 0-3-3. Preq., senior standing in CMEN. A study of the legislation, regulation, technology, and business matters relating to hazardous waste management. (G)

475: Combustion, Fires and Explosions. 0-3-3. Preq., senior standing in CMEN. Nature of combustion, controlled and free burning fires, and evaluation of explosion hazards. (G)

501: Advanced Unit Operations. 0-3-3. Design calculations applicable to various unit operations including drying, humidification, absorption, adsorption, distillation, heat exchangers, ion exchange, cooling towers and filtration.

504: Advanced Chemical Engineering Kinetics. 0-3-3. Homogeneous reactions. Catalytic reactions. Mass and heat transfer in catalytic beds. Catalytic reactor design. Uncatalyzed heterogeneous reactions.

513: Transport Phenomena. 0-3-3. A course in which advanced concepts on momentum, energy, and mass transport is explored. Emphasis is placed on unsteady state behavior, turbulence, and recent developments in the literature.

521: Energy Analysis of Industrial Processes. 0-3-3. Preq., An undergraduate course in thermodynamics. The application of the concept of exergy, or energy availability, to the systematic analysis of processes and plants to make most efficient use of limited energy resources.

522: Advanced Thermodynamics. 0-3-3. The relations of thermodynamic properties are developed. Problems on the expansion and compression of non-gases, liquefaction, low temperature separation are studied.

524: Seminar. 0-1-1 each. Surveys, investigations, and discussions of current problems in Chemical Engineering.

550: Special Problems. 1-4 semester hours. Preq., consent of instructor. Selected topics dealing with advanced problems in chemical engineering and design of equipment. The problems and projects will be treated by current methods used in professional practice.

551: Research and Thesis in Chemical Engineering. Registration in any quarter may be for three semester hours credit or multiples thereof. Maximum credit allowed is six semester hours.

555: Practicum. 0-3-3 (6). Preq., 12 semester hours of graduate work. Analytical and/or experimental solution of an engineering problem; technical literature survey required; development of engineering research techniques.

557: Special Topics: Chemical Engineering. 0-3-3 (9). The topic or topics will be selected by the instructor from the various sub-areas of chemical engineering. May be repeated as topics change.

CHEMISTRY (CHEM)

100: General Chemistry. 0-2-2. Preq., or Coreq., MATH 101, or 111, or 240. Fundamental principles of chemistry: Chemistry and measurement, atomic symbols and chemical formulas, stoichiometry, gases and thermochemistry.

101: General Chemistry. 0-2-2. Preq., CHEM 100. Continuation of CHEM 100: Atomic and molecular structure, theories of molecular bonding, liquids, solids and solutions.

102: General Chemistry. 0-2-2. Preq., CHEM 101. Continuation of CHEM 101: Rates of reaction, study of chemical equilibria including those

- involving acids, bases, sparingly soluble salts and complex ions, thermodynamics of equilibrium and introductory electrochemistry.
- 103: General Chemistry Laboratory.** 4 1/4-0-1. Coreq., CHEM 101. Laboratory practice in general chemistry.
- 104: General Chemistry Laboratory.** 4 1/4-0-1. Preq., CHEM 103. Continuation of CHEM 103.
- 107: General Chemistry.** 0-3-3. Preq., or Coreq., MATH 101, or 111, or 240. Fundamental principles of chemistry; chemistry and measurement, atomic symbols and chemical formulas, stoichiometry, gases and thermochemistry. Atomic and molecular structure, theories of molecular bonding.
- 108: General Chemistry.** 0-3-3. Preq., CHEM 107. Continuation of CHEM 107. Liquids, solids, and solutions. Rates of reaction, study of chemical equilibria including those involving acids, bases, sparingly soluble salts and complex ions, thermodynamics of equilibrium and introductory electrochemistry.
- 120: An Introduction to Inorganic Chemistry.** 0-3-3. Topics covered will include scientific units, states of matter, the electronic structure of atoms, the chemical bond, solutions, reaction kinetics, acid-base theory, and buffers.
- 121: An Introduction to Organic Chemistry and Biochemistry.** 0-3-3. Preq., CHEM 120 or 102. Survey of hydrocarbons and their derivatives; biomolecules including proteins, sugars, lipids, and nucleic acids. Not to be used as a prerequisite for advanced chemistry courses.
- 122: Chemistry Laboratory.** 4-0-1. Preq., CHEM 120. Basic laboratory experiments in inorganic, organic, and biochemistry.
- 205: Analytical Chemistry.** 4 1/4-3-4. Preq., CHEM 102. Theory and practice of analytical Chemistry.
- 250: Organic Chemistry.** 0-2-2. Preq., CHEM 102. Introduction to organic chemistry with emphasis on structure and reactivity of aliphatic hydrocarbons and alkyl halides.
- 251: Organic Chemistry.** 0-2-2. Preq., CHEM 250; Coreq., CHEM 253. Continuation of CHEM 250 with emphasis on aromatic hydrocarbons, alcohols, aldehydes, ketones, and related reaction mechanisms and spectroscopy.
- 252: Organic Chemistry.** 0-2-2. Preq., CHEM 251; Coreq., CHEM 254. Continuation of CHEM 251 with emphasis on carbonyl compounds, aliphatic and aromatic amines, phenols, carbohydrates and related reaction mechanisms.
- 253: Organic Chemistry Laboratory.** 4 1/4-0-1. Preq., CHEM 102; Coreq., CHEM 251. Selected experiments emphasizing both laboratory operations and related basic principles and mechanisms.
- 254: Organic Chemistry Laboratory.** 4 1/4-0-1. Preq., CHEM 253; Coreq., CHEM 252. Introduction to multi-step organic syntheses and related reaction mechanisms.
- 281: Inorganic Chemistry.** 4 1/2-2-3. Preq., CHEM 102 and 104. Introduction to inorganic chemistry, including a systematic study of the periodic table with emphasis on structure, properties and reactivity of the elements of inorganic compounds.
- 301: Introductory Physical Chemistry.** 0-3-3. Preq., CHEM 102 and MATH 112 or 241. An introduction to physical chemistry, with emphasis on properties of gases, thermodynamics, chemical equilibrium, ionic equilibria, chemical kinetics, and molecular spectroscopy.
- 311: Physical Chemistry.** 0-3-3. Preq., CHEM 102 and 252, MATH 231 and PHYS 202 or 209. Basic theories of chemistry with emphasis on gases, chemical thermodynamics and phase equilibria.
- 312: Physical Chemistry.** 0-3-3. Preq., CHEM 311. Basic theories of chemistry with emphasis on chemical kinetics, quantum theory, statistical thermodynamics and molecular spectroscopy.
- 313: Physical Chemistry Laboratory.** 4 1/4-0-1. Coreq., CHEM 311. Laboratory experiments in physical chemistry.
- 314: Physical Chemistry Laboratory.** 4 1/4-0-1. Preq., CHEM 311; Coreq., CHEM 312. Continuation of CHEM 313.
- 351: Biochemistry.** 0-3-3. Preq., CHEM 252, 254. The chemistry of biologically important compounds including fats, carbohydrates, proteins, enzymes, vitamins, and hormones.
- 352: Biochemistry.** 0-3-3. Preq., CHEM 351. Intermediary metabolism and molecular biology of the gene.
- 353: Biochemistry Laboratory.** 4 1/4-0-1. Coreq., CHEM 351. Techniques applicable to current biochemistry with emphasis on basic research procedures.
- 354: Biochemistry Laboratory.** 4 1/4-0-1. Preq., CHEM 351 and CHEM 353. Techniques applicable to current biochemistry with emphasis on metabolism and molecular biology.
- 409: Advanced Organic Chemistry.** 0-3-3. Preq., CHEM 381 and 312. Introduction to theoretical organic chemistry with emphasis on carbocation chemistry and pericyclic reactions.
- 420: Chemical Thermodynamics.** 0-3-3. Preq., CHEM 312. An introduction to chemical thermodynamics.
- 424: Advanced Physical Chemistry.** 0-3-3. CHEM 312 or PHYS 410 and MATH 245. A continuation of CHEM 311-312, including an introduction to quantum chemistry, and a quantum mechanical approach to the study of the structure of atoms and molecules.
- 450: Chemical Topics.** 1-4 hour(s) credit (8). Preq., CHEM 312 and consent of instructor. An opportunity to observe and discuss topics of current interest in the chemical sciences. Offered on demand.
- 466: Instrumental Analysis.** 8 1/2-2-4. Preq., CHEM 312. Theory and practice of optical methods of analysis, advanced electrical techniques, and modern separation methods. (G)
- 470: Methods, Materials and Activities for Teaching Chemistry.** 0-3-3. Preq., CHEM 102 and instructor permission. A course especially designed for the high school chemistry instructor.
- 471: Methods, Materials and Activities for Teaching Chemistry.** 4 1/2-3-4. Preq., CHEM 102 and instructor's permission. A continuation of CHEM 470.
- 481: Advanced Inorganic Chemistry.** 4 1/2-2-3. Preq., CHEM 252, 312. An advanced study of the periodic classification of elements, their reactions, and other inorganic principles. (G)
- 490: Chemistry Seminar.** 0-1-1 (3). Preq., Senior or graduate standing. Required of chemistry graduate students. Supervised organization and presentation of topics from the chemical literature. (G)
- 498: Undergraduate Research.** 1-3 hours credit (6). Preq., consent of instructor. Introduction to methods of research and completion of a basic research problem.
- 501: Physical Organic Chemistry.** 0-3-3. Preq., CHEM 409. An advanced study of the mechanisms of organic methodology used in their investigations, and organic quantum chemistry.
- 502: Selected Topics in Organic Chemistry.** 0-3-3 (6). Preq., CHEM 409. Areas covered will vary; however they will generally include advanced organic synthesis and related structure identification with emphasis on spectroscopic techniques.
- 503: Topics in Chemistry.** 1-3 hours credit (6). Independent study. Topics arranged to meet the needs of the student.
- 520: Molecular Spectroscopy.** 0-3-3. Preq., CHEM 312. The relationship between molecular spectra and molecular structure.
- 523: Special Topics in Physical Chemistry.** 0-3-3. Preq., CHEM 312. Topics will vary and will include kinetic theory of gases, molecular structure, phase rule, photochemistry, nuclear chemistry, chemical kinetics, or statistical thermodynamics.
- 524: Quantum Chemistry.** 0-3-3. Preq., CHEM 312 or PHYS 410. Physical and chemical applications of quantum theory.
- 549: Practicum in Chemistry.** 0-3-3 (6). Preq., 12 semester hours of graduate work. Experimental or computational study of a problem in chemistry. A survey of the relevant literature and a formal written report are required.
- 551: Research and Thesis in Chemistry.** Registration in any quarter may be for three-semester hours credit or multiples thereof. Maximum credit allowed is six semester hours.
- 555: Special Topics in Biochemistry.** 0-3-3 (9). Preq., CHEM 352. Topics covered will vary and may include toxicology and clinical biochemistry.
- 556: Protein Chemistry.** 0-3-3. Preq., CHEM 351. The chemical nature and physiology of both structural and metabolic proteins.
- 563: Advanced Analytical Chemistry.** 0-3-3. Preq., CHEM 466. Theoretical aspects of the optical, chemical, and separation techniques of analytical chemistry.
- 564: Selected Topics in Analytical Chemistry.** 0-3-3. The topic or topics will be selected in the general areas of chemical separations or spectroscopy by the instructor. (TECH-NLU Collaborative).
- 584: Chemistry of Coordination Compounds.** 0-3-3. Preq., CHEM 481. A study of the structure, preparation, and properties of coordination compounds.
- 586: Special Topics in Inorganic Chemistry.** 0-3-3. Preq. CHEM 584 or instructor's permission. A topic will be selected on a rotating basis from the following: magnetic and electric properties, solid state structures, catalysis, and group theory applications of inorganic materials.

CIVIL ENGINEERING (CVEN)

- 202: Civil Engineering Materials Laboratory.** 4-0-1. Coreq., concurrent with MEMT 201. Introduction to laboratory testing of aggregates, concrete, asphalt, steel, and other materials used by civil engineers.
- 254: Plane Surveying.** 4-2-3. Preq., MATH 112 or 240. Theory, field measurements, and computation and error analysis associated with land, traverse, and topographic surveys.
- 291: Civil Engineering Computations.** 3-1-2. Preq., MATH 241. Application of microcomputers in civil engineering. Numerical techniques and statistical applications, personal productivity tools, application software.
- 300: The Civil Engineering Profession.** 0-3-3. Preq., sophomore standing. Open only to civil engineering students. The civil engineering profession and its effect on society. History and heritage, current professional practices and techniques, concepts and challenges for the future.
- 304: Remote Sensing.** 4-1-2. Preq., MATH 112 or 241. Basic introduction to remote sensing. Measurements and mapping from aerial photographs. Photo interpretation. Height determination by parallax.
- 310: Water Resources I.** 0-3-3. Preq., MEMT 313. Hydrologic and hydraulic analysis of precipitation and runoff, storm water management, detention basin design, and flood frequency analysis.
- 314: Environmental Engineering.** 3-2-3. Preq., ENGL 303, CHEM 103, . Introduction to the unit operations and processes most often encountered in water and wastewater treatment.
- 324: An Introduction to Soils Engineering.** 4-1-2. Preq., ENGL 303, MEMT 211. Introduction to soil mechanics and its application to civil engineering. A presentation of soil properties and characteristics pertinent to an evaluation of various engineering situations, problems and designs.
- 325: Introduction to Foundation Engineering.** 0-3-3. Preq., CVEN 324. Consideration of bearing capacity, settlement of structures, slope stability, foundation design requirements, subsurface exploration, regional soil conditions, footings, mats, and retaining walls.
- 332: Transportation Engineering I.** 0-3-3. Preq., ENGR 122. Introduction to transportation facilities; urban transportation planning; traffic, design, safety, and the environment.
- 333: Transportation Engineering II.** 3-2-3. Preq., CVEN 332. Design of highway and airport runway elements in a laboratory and field environment.
- 340: Structural Analysis & Design.** 3-2-3. Preq., MEMT 211. Analysis of simple and continuous structures using classical and matrix methods. Introduction to structural design concepts.
- 341: Steel & Reinforced Concrete Design.** 3-2-3. Preq., CVEN 340. Design of steel and reinforced concrete structures with emphasis on behavior of tension and compression members, beams, and slabs. Steel connections in elementary structures.
- 355: Advanced Surveying.** 4-2-3. Preq., CVEN 254. Advance error propagation theory, including an introduction to least squares. Various horizontal/vertical high precision surveys; geodetic concepts and surveys; Global Positioning Systems.
- 357: Engineering and Construction Surveying.** 4-1-2. Preq., CVEN 254. Horizontal/vertical curves; earthwork; topographic/planimetric surveys for map/drawing construction; engineering use of State Plane Coordinate System; surveys for buildings, pipelines, and others.
- 410: Air Pollution Fundamentals.** 0-3-3. Preq., Senior standing in an engineering curriculum, or consent of instructor. History of air pollution legislation, sources, and effects of major air pollutants, and predictive capabilities with regard to air pollution. (G)
- 411: Water Resources II.** 3-2-3. Preq., CVEN 310. Computer modeling of precipitation and runoff, open channel hydraulics, flood profiles, pipe networks. Applications of modeling software for hydrologic and hydraulic design.
- 412: Environmental Impact Analysis.** 0-3-3. Preq., Senior standing in Civil Engineering or the consent of the instructor. Definition and quantification of environmental impact. Types of environmental impact studies. (G)
- 414: Bituminous Mixture Design.** 3-2-3. Preq., senior standing. Selection of binders and aggregates for mixture design processes. Methods include Marshall, Hveem and SUPERPAVE. Laboratory mixes will be designated and tested. (G)
- 416: Hydraulic Facilities Design.** 0-3-3. Preq., MEMT 313. Basic concepts of open channel flow. Computation of uniform and non-uniform flow. Hydraulic design of spillways, stilling basins, canals, transitions, culverts, and bends. (G)
- 417: Groundwater Hydrology.** 0-3-3. Preq., CVEN 310. Groundwater occurrence, movement and quality, well hydraulics, basin development, and model studies. (G)
- 421: Portland Cement Concrete.** 0-3-3. Preq., consent of instructor. Production, testing, uses, and performance of Portland cement and Portland cement concrete (PCC). Detailed investigation into PCC components. Admixtures and special concretes. (G)
- 422: Geometric Design.** 0-3-3. Preq., CVEN 332. Functional design of highways, railroads and runways with emphasis on safety and efficiency of flow set intersections, curves, and interchanges. (G)
- 423: Introduction to Asphalt Technology.** 3-2-3. Preq., senior standing, or consent of instructor. Production and uses of asphalt; measurement and significance of laboratory properties including viscosity, penetration, flash point, ductility, solubility, thin film oven test and specific gravity. (G)
- 424: Seminar.** 0-1-1. Preq., Senior standing. Reading and discussion of assigned papers, informal talks by instructors and professional engineers, debates on matters of current interest.
- 425: Traffic Engineering.** 0-3-3. Preq., CVEN 332. Traffic characteristics, vehicle operating characteristics, traffic control, and design of traffic facilities. Basic traffic studies, capacity, signing and signalization, speed regulation and parking. (G)
- 427: Design of Highway Pavements.** 0-3-3. Preq., CVEN 324. Flexible and rigid pavement types. Factors affecting stresses and strains in pavement layers. Design criteria and structural design methods for highway pavements. (G)
- 436: Construction Equipment and Methods.** 0-3-3. Preq., Junior standing, and ENGR 122 or INEN 300. Study of economics and functional applications of construction equipment. Operation characteristics are identified for selected equipment items, and are applied to typical construction situations. (G)
- 437: Contracts and Specifications.** 0-2-2. Preq., CVEN 439. Legal documents of construction contracts. (G)
- 438: Estimating.** 0-3-3. Preq., CVEN 254 and junior standing. Types of estimates. Material takeoff from blueprints and specifications. Detailed estimates of labor and materials. Approximate estimates. (G)
- 439: Construction Planning, Contracts and Specifications.** 0-3-3. Preq., Junior standing and either INEN 300 or ENGR 122. Introduction to methods for planning, estimating, and controlling projects, construction contracts, specifications and cost impacts. Term projects required. Team efforts on problems and case studies. (G)
- 440: Foundation Engineering.** 0-3-3. Preq., CVEN 325 or consent of instructor. Theory and applications in foundation engineering design; application of soil mechanics. (G)
- 443: Analysis of Continuous Structures.** 0-3-3. Preq., CVEN 340; Slope-deflection, moment distribution plastic design, matrix applications, STRUDEL language.
- 450: Special Problems.** 1-4 hours credit. Preq., senior standing and consent of instructor. Planning, organization, and solution of problems in Civil Engineering.
- 456: Legal Aspects of Boundary Surveying.** 0-3-3. Preq., CVEN 254 or consent of instructor. Legal aspects of various boundary systems. Legal principles of boundary surveys: common statute law, written/unwritten rights and rules of evidence, property descriptions/layout.
- 457: Practical Surveying.** 40-0-3. Preq., CVEN 355, 357, or 456. An on-the-job training program; student is employed by registered professional surveyor for 300 working hours (minimum); work to be approved by program chair.
- 458: Introduction to Geographic Information Systems.** 0-3-3. Preq., senior standing, or approval of instructor. Basic principles, functions, and engineering applications of spatial information systems; introduction to databases. Team case studies using GIS software. (G)
- 459: Introduction to Infrastructure Management.** 0-3-3. Preq., junior standing. Lifecycle approach to planning, designing, and managing infrastructure (highways, streets, utilities); infrastructure decision support systems; performance measures and prediction; computer applications; case studies. (G)
- 464: Advanced Design of Concrete Structures.** 0-3-3. Preq., CVEN 341. Advanced topics in the design of reinforced and prestressed concrete structures. (G)
- 466: Advanced Structural Design.** 0-3-3. Preq., CVEN 341. Advanced topics in the design of steel and timber structures. Load and resistance factor design. (G)

- 468: Computational Structural Design.** 0-3-3. Preq., CVEN 341. An introduction to the use of computational techniques for designing structures. Finite element method. Structural optimization. (G)
- 480: Introduction to Trenchless Technology.** 0-3-3. Preq., CVTE 210 or MEMT 313. Basic technologies, design considerations and construction practices for underground infrastructure construction and rehabilitation with minimal ground surface disturbance.
- 492: Civil Engineering Design I.** 3-0-1. Preq., senior standing and within 3 quarters of graduation. Open-ended design problems typical of those encountered in the Civil Engineering profession and calling for the integration of geotechnical, structures, transportation and water resources.
- 493: Civil Engineering Design II.** 3-0-1. Preq., Coreq., CVEN 492. A continuation of CVEN 492.
- 494: Civil Engineering Design III.** 3-0-1. Preq., CVEN 492; Coreq., CVEN 493. A continuation of CVEN 493.
- 495: Computer-Aided Civil Engineering Design.** 4-2-3. Preq., Senior standing in Civil Engineering or consent of instructor. Integration of computers in civil engineering design applications. Emphasis is on design methodologies. Specific software applications vary. (G)
- 501: Frame Analysis.** 0-3-3. Preq., CVEN 340. Single and multi-story frames by moment distribution, slope deflection and column analogy methods. Frames and beams with variable cross-section. Secondary stresses in trusses. Dimensional analysis and theory of models.
- 509: Dynamic Analysis of Structures.** 0-3-3. Preq., MATH 245. Analysis of structures (SDOF and MDOF) under wind, wave, earthquake and impact forces.
- 510: Advanced Soil Mechanics.** 0-3-3. Preq., CVEN 324. Evaluation of subsoil conditions, theory of consolidation and bearing capacity of soils; selection application and design of foundation elements of structures.
- 512: Design of Deep Foundations.** 0-3-3. Preq., CVEN 440. Analysis and design of pile foundations, drilled shafts, piers and sheeting support systems.
- 514: Bituminous Mixture Design.** 3-2-3. Selection of binders and aggregates for mixture design processes. Methods include Marshall, Hveem and SUPERPAVE. Laboratory mixes will be designed and tested.
- 517: Advanced Pavement Design.** 0-3-3. Preq., CVEN 427 or consent of instructor. Traffic and loading considerations for airfield pavements. Structural design methods for highway and airfield pavements, with emphasis on computerized design and analysis techniques.
- 519: Techniques for Pavement Rehabilitation.** 0-3-3. Evaluation of roadway distress, roughness, friction, drainage and structural surveys will be discussed. Survey results used to identify cost-effective techniques for pavement rehabilitation.
- 522: Design of Temporary Structures.** 0-3-3. Advanced topics in the design of temporary structures required for complex construction projects.
- 527: Statistical Methods in Hydrology.** 0-3-3. Preq., CVEN 310. Frequency analysis, extreme value distribution, error analysis, and multiple regression analysis associated with making engineering decisions using hydrologic data.
- 530: Water Quality Improvement.** 3-2-3. Preq., CVEN 314 or consent of instructor. Stream self-purification processes. Pollution abatement methods. Industrial waste surveys. Principles of treatment for domestic and industrial wastewaters.
- 531: Contaminant Transport.** 0-3-3. Preq., CVEN 314, 310, or consent of instructor. Mathematical modeling of contaminant transport in surface and ground water systems.
- 536: Wastewater Disposal Systems.** 3-2-3. Preq., CVEN 314. Advanced problems in design of domestic and industrial waste treatment systems.
- 550: Special Problems.** 1-4 hours credit. Advanced problems in Civil Engineering will be assigned according to the ability and requirements of the student. An opportunity will be afforded to plan, organize, and complete solutions in problems of considerable magnitude with a view toward developing confidence and self-reliance.
- 551: Research and Thesis in Civil Engineering.** Registration in any quarter may be for three semester hours credit or multiples thereof. Maximum credit allowed is six semester hours.
- 555: Research and Communications Seminar.** 0-3-3. Preq., 12 semester hours of graduate work. Oral and written communication of literature search.
- 557: Special Topics: Civil Engineering.** 0-3-3 (9). The topic or topics will be selected by the instructor from the various sub-areas of civil engineering. May be repeated as topics change.

- 560: Transportation Systems Planning.** 4-2-3. Preq., CVEN 332. A study of transportation systems as they affect travel behavior of a populace and the location of economic activities.
- 561: Traffic Engineering Characteristics.** 0-3-3. Preq., consent of instructor. Traffic laws, ordinances, and control devices; intersection characteristics, pretimed control, traffic actuated control, arterial and network progression.
- 564: Feasibility Analysis of Transportation Systems.** 0-3-3. Preq., consent of instructor. Goals, objectives and criteria used for decision making for transportation investments; economic analysis and treatment of intangibles and risk; non-users impact analysis.
- 578: Applications of Nonlinear Finite Element Analysis to Civil Engineering Problems.** 0-3-3. Preq., MEMT 508 or consent of instructor. Application of the theory of the finite element method to nonlinear problems in Civil Engineering.
- 579: Advanced Structural Dynamics.** 0-3-3. Advanced studies of the dynamic response of structures including experimental, analytical and computational procedures. Particular emphasis is given to Civil Engineering applications with a consideration of multiple degrees-of-freedom and continuous systems.
- 580: Trenchless Technology.** 0-3-3. Preq., MEMT 313 and CVEN 324. Survey of trenchless technologies, underground infrastructure management, cured-in-place, slip lining and fold and form rehabilitation, horizontal directional drilling, pipe jacking and microtunneling. Credit will not be given for both CVEN 480 and 580.
- 599: Graduate Seminar.** 0-1-1. Issues in graduate education. Presentations of current topics in research, teaching and practice. May be repeated for credit. (Pass/Fail).

CIVIL TECHNOLOGY (CVTE)

- 100: Introduction to Construction.** 3-2-3. An introduction to the construction industry, the work of professional construction managers and technologies, the curriculum, and the reading of building and highway plans.
- 210: Basic Hydraulics.** 4-2-3. Preq., MEMT 206. Physical phenomena of hydraulics with application of the fundamental laws and empirical formulae. Pressure forces on submerged areas, buoyancy, flow in closed conduits and open channels and fluid measurements.
- 372: Structural Mechanics and Analysis.** 0-3-3. Preq. MEMT 206 and MATH 220. Theory of the mechanics of structural analysis and design. Not open to Civil Engineering majors.
- 373: Construction Materials.** 4-2-3. Preq., ENGL 303 and MEMT 206. Mechanical behavior of engineering materials, determination of strength and other properties of materials, and construction applications.
- 424: Seminar.** 3-0-1. Preq., senior status. Reading and discussion of assigned papers, presentation of current issues in construction, and discussions with professional construction personnel.
- 471: Reinforced Concrete, Foundations, and Formwork.** 0-3-3. Preq., CVTE 372. Analysis and design of reinforced concrete structures, slabs, and footings. Design and selection of formwork and shoring.
- 473: Design of Structures.** 3-2-3. Preq., CVTE 372. Design of elementary structures in timber and steel.
- 475: Soils in Construction.** 0-3-3. Preq., MEMT 206. The nature of soils, earthwork in construction and soils testing methods.
- 492: Construction Project Bid Planning.** 6-0-2. Preq., CVEN 439 and senior standing. Capstone construction experience that includes planning the sequence of construction operations, creating a bill of materials, and estimating the cost of a small construction project by student teams.

CLINICAL LABORATORY SCIENCE (CLAB)

- 450: Pathophysiology.** 0-3-3. A case history approach is taken in the correlation of laboratory data with clinical observation to diagnose disease.
- 451: Laboratory Studies in Pathophysiology.** 4 1/4-0-1. Preq., or Coreq., CLAB 450. Student application of modern laboratory techniques used in the clinical pathology laboratory with emphasis on clinical hematology, clinical chemistry, urodynamics and clinical immunology.
- 457: Professional Practices.** 0-2-2. Healthcare administration, educational techniques, career opportunities/ development, QA/QA, ethics, interview techniques, plus credentialing and accreditation in medical technology are discussed.

- 460: Clinical Hematology.** 2-6 semester credit hours. Preq., consent of instructor. Advanced concepts in the theory, application and medical interpretation of hematological and hemostatic mechanisms and methods.
- 461: Clinical Hematology Laboratory.** 1-5 semester credit hours. Preq., consent of instructor. Instruction and laboratory practice in the development and use of advanced analytical procedures and instrumentation in clinical hematology and hemostasis.
- 462: Clinical Serology and Immunology.** 1-4 semester credit hours. Preq., consent of instructor. Advanced concepts in the theory, application and medical interpretation of serological and immunological mechanisms and methods.
- 463: Clinical Serology and Immunology Laboratory.** 1-4 semester hours credit. Preq., consent of instructor. Practical instruction and laboratory practice in the performance of serological and immunological procedures.
- 464: Clinical Bacteriology.** 2-5 semester credit hours. Preq., consent of the instructor. Advanced concepts in the use and interpretation of medical bacteriological procedures and data.
- 465: Clinical Bacteriology Laboratory.** 3-6 semester credit hours. Preq., consent of the instructor. Instruction and laboratory practice in the development and use of advanced analytical procedures and instrumentation in clinical bacteriology.
- 466: Clinical Immunohematology.** 1-4 semester credit hours. Preq., consent of the instructor. An advanced study of the principles of immunohematology necessary to provide a patient with a safe blood transfusion.
- 467: Clinical Immunohematology Laboratory.** 1-4 semester credit hours. Preq., consent of instructor. Practical instruction and laboratory practice in immunohematological procedures utilized in a hospital blood bank.
- 468: Clinical Chemistry.** 3-6 semester credit hours. Preq., consent of the instructor. Advanced concepts in the theory application, and medical interpretation of clinical biochemical mechanisms and methods.
- 469: Manual Clinical Chemistry Lab.** 1-3 semester credit hours. Preq., consent of instructor. Practical instruction and laboratory practice in the performance of manual clinical chemistry procedures.
- 470: Special Clinical Chemistry Laboratory.** 1-3 semester credit hours. Preq., consent of instructor. Practical instruction and laboratory practice in the performance of special clinical chemistry procedures.
- 471: Automated Clinical Chemistry Lab.** 1-2 semester credit hours. Preq., consent of instructor. Practical instruction and lab practices in the performance of automated clinical chemistry procedures.
- 472: Clinical Chemistry Toxicology Laboratory.** 1-2 semester credit hours. Preq., consent of instructor. Practical instruction and laboratory practice in the performance of toxicological procedures.
- 473: Clinical Chemistry Radioimmunoassay Laboratory.** 1 semester credit hour. Preq., consent of instructor. Practical instruction and laboratory practice in the performance of radioimmunoassay procedures.
- 474: Clinical Urinalysis.** 1-3 semester credit hours. Preq., consent of instructor. Advanced concepts in the use and interpretation of urinalysis procedures and data.
- 475: Clinical Urinalysis Laboratory.** 1-3 semester credit hours. Preq., consent of instructor. Practical instruction and laboratory practice in the performance of urinalysis procedures.
- 476: Clinical Parasitology, Mycology and Mycobacteriology.** 1-2 semester credit hours. Preq., consent of instructor. Advanced concepts in the use and interpretation of procedures and data in clinical parasitology, mycology, and mycobacteriology.
- 477: Clinical Parasitology, Mycology and Mycobacteriology Laboratory.** 1-2 semester credit hours. Preq., consent of instructor. Instruction in laboratory practice in the development and use of advanced analytical procedures in clinical mycology, parasitology, and mycobacteriology.
- 478: Clinical Laboratory Administration.** 1-2 semester credit hours. Preq., consent of instructor. Modern management concepts for the clinical laboratory.
- 479: Clinical Histopathology.** 1-5 semester credit hours. Preq., consent of instructor. Advanced concepts in the use and interpretation of histotechnological procedures and findings.
- 480: Clinical Medical Technology Problems.** 1-8 semester credit hours. Preq., consent of instructor. An introduction to emerging medical technologies.
- 483: Clinical Parasitology.** 1-2 semester credit hours. Identification, clinical significance, and methods of prevention of parasitic infections.
- 484: Clinical Parasitology Laboratory.** 1-2 semester credit hours. Instruction and laboratory practice in the development and application of medical parasitology laboratory methods.

- 485: Clinical Mycology.** 1-2 semester credit hours. Identification, clinical significance and methods of prevention of mycotic infection.
- 486: Clinical Phlebotomy and Specimen Procurement.** 1-3 semester credit hours. Preq., consent of instructor. Instruction and laboratory practice in phlebotomy and the collection of other specimens for clinical analysis. Specimen preservation and safe lab practices are included.
- 487: Clinical Hemostasis.** 1-4 semester hours credit. Preq. consent of instructor. The theory of the coagulation cascade, analytical procedures that monitor this process and the clinical significance of coagulopathies are discussed.
- 488: Clinical Hemostasis Laboratory.** 1-4 semester hours credit. Laboratory procedures which assess the coagulation cascade and related processes.
- 489: Clinical Chemistry Laboratory.** 3-8 semester hours credit. Practical instruction and laboratory practice in clinical chemistry procedures, including associated instrumental analysis.

COMPUTER INFORMATION SYSTEMS (CIS)

- 102: Typewritten Communication.** 0-3-3. Preq., Basic knowledge in typewriting/keyboarding. Emphasis on formatting and production of typewritten communications including business forms, internal and external correspondence, and complicated reports. (Meets intermediate typewriting requirements for Business Education majors.)
- 110: Computer Tools for Business.** 1-2-3. The development and enhancement of computer skills and knowledge using current business software.
- 310: Principles of Information Systems.** 0-3-3. Preq., CIS 110, junior standing. Introduction to concepts and principles of information system resources, analysis, development, management, and applications.
- 323: Database System Management.** 0-3-3. Preq., CIS 310, 339. Managing and communicating the data resource using database principles and user-oriented data languages.
- 335: Application Development for the Internet.** 0-3-3. Preq., CIS 310, 339. Programming for Internet- and Intranet-based business applications. The principles of good software engineering and program clarity will be stressed.
- 337: Business Applications Development: Current Programming Techniques.** 0-3-3. Preq., CIS 310, 339. Provides overview of business application development, using program development methodology. Emphasizes object-oriented and data-driven languages for business students with limited programming background.
- 339: Business Applications with COBOL.** 0-3-3. Preq., CIS 110. Applying program and file structures to design programs for business applications. Development of COBOL language skills for coding the designs.
- 401: Internship in CIS I.** 3 hours credit. (Pass/Fail) Preq. consent of instructor and senior standing. On site, supervised, structured work experiences in the field of business.
- 402: Internship in CIS II.** 3 hours credit. (Pass/Fail) Preq. consent of instructor and senior standing. On site, supervised, structured work experiences in the field of business.
- 444: Network Design & Implementation.** 0-3-3. Preq., CIS 310, 339. Issues of designing, implementing, and managing computer networks, including both Local Area Networks (LANs) and Wide Area Networks (WANs). (G)
- 450: Systems Analysis, Design, & Implementation.** 0-3-3. Preq., CIS 323, 444. An in-depth life cycle approach to information systems analysis, design, and implementation. (G)
- 510: Information Resource Management.** 0-3-3. Attention is given to strategic implementation of technology, secure and effective systems, externally focused systems, along with the historical and social environment of information systems.
- 515: Decision Support Systems.** 0-3-3. Information technology in the firm and non-profit organization with a focus on using computers, data bases, knowledge bases, graphics, and models to support decision making.
- 535: Advanced Computer Applications.** 0-3-3. Study of the development and application of Expert Systems and use of development shells. Topics include: Knowledge Acquisition, System Development, and Validation/Verification.
- 550: Directed Study in Computer Information Systems.** 1-3 hours credit. Hours and credits to be arranged. Consent of instructor and approval of department head required. Special problem or specific area of computer information systems.
- 615: Decision Support Systems.** 0-3-3. Requires Doctoral standing. May require additional class meetings. Information technology in the firm and non-profit organization with a focus on using computers, data bases,

knowledge bases, graphics, and models to support decision making. Credit will not be given for CIS 615 if credit is given for CIS 515.

- 625: Information Systems Project Management.** 0-3-3. Preq., DBA student or consent of instructor. Intensive review of theories and literature on information systems (IS) project development and management. IS project management techniques and managerial issues will be examined. A research project proposal in IS management will be developed and completed.
- 630: Seminar in Computer Information Systems.** 0-3-3. Study of current topics in the discipline of Computer Information Systems. In-depth analysis of a specialized research field along with an investigation of the literature.
- 635: Advanced Computer Applications.** 0-3-3. Requires Doctoral standing. May require additional class meetings. Study of the development and application of Expert Systems and use of development shells. Topics include: Knowledge Acquisition, System Development, and Validation/Verification. Credit will not be given for CIS 635 is credit is given for CIS 535.
- 650: Directed Study in Computer Information Systems.** 1-3 hours credit. Hours and credits to be arranged. Consent of instructor and approval of department head required. Special problem or specific area of computer information systems.
- 685: Comprehensive Exam in Computer Information Systems.** No credit. Doctoral standing required. Required for all business administration doctoral students seeking to take the comprehensive exam in CIS. Successful completion is a prerequisite to the oral comprehensive exam for those seeking a primary field or examined minor in CIS. Requires consent of graduate director.

COMPUTER SCIENCE (CSC)

- 100: Overview of Computer Science.** 0-3-3. Preq., MATH 101 or equivalent. An overview of the field of computing; history, impact on society, and current trends; together with an introduction to operating systems, editors, and rudimentary programming.
- 102: Programming with FORTRAN.** 0-3-3. Preq., Eligible for MATH 111 or 240. Problem analysis, algorithm development, data and control structures, and interpretation of results, with emphasis on numerical applications.
- 109: Computer Programming.** 0-3-3. (cannot be taken for credit toward any Computer Science degree) Fundamentals of computer programming. Emphasis is placed on problem analysis, algorithm development, and data and control structures.
- 120: Introduction to Computer Programming.** 0-3-3. Preq., CSC 100 or equivalent and MATH 111 or 240. An introduction to program development. Emphasis is placed on problem analysis, algorithm development, data and control structures.
- 210: Discrete Mathematics for Computer Scientists.** 0-3-3. Preq., CSC 120 and MATH 112 or 241. An overview of the mathematical foundations of computing. Topics include sets, symbolic logic, relations, functions, combinatorics, induction, trees, graphs, and Boolean algebra.
- 220: Data Structures.** 0-3-3. Preq., CSC 120. The definition, representation, and manipulation of basic data structures such as arrays, stacks, queues, trees, and graphs. Practical applications of these structures will be emphasized.
- 230: Software Design.** 0-3-3. Preq., CSC 220. Design, construction and maintenance of large software systems. Topics include project planning, requirements analysis, software design methodologies, software implementation and testing, maintenance.
- 240: Introduction to Concurrent Programming.** 0-3-3. Preq., CSC 220. Fundamentals of concurrent, parallel, and distributed computing. Topics include semaphores, monitors, rendezvous, remote procedure calls, and asynchronous message passing, SIMD model, MIMD architectures.
- 251: Computer Organization & Assembly Language.** 0-3-3. Preq., CSC 220. Introduction to computer organization and operation, data representation and manipulation, assembly language programming, register level operations, peripheral device interfaces.
- 265: Introduction to Digital Design.** 0-2-2. Preq., CSC 251; Coreq., CSC 269. Introduction to digital design techniques, Boolean algebra, combinational logic, minimization techniques, simple arithmetic circuits, programmable logic, sequential circuit design, registers and counters.
- 269: Digital Design Lab.** 3-0-1. Coreq., CSC 265. Laboratory for digital design techniques, combinational and sequential logic design, registers and counters.

- 299: Cooperative Education Applications.** 40-0-1 (7). Preq., Admission to the College of Engineering and Science Cooperative Education Program. Pass/Fail.
- 310: Theory of Computing.** 0-3-3. Preq., CSC 220 and MATH 311. An overview of formal languages, the abstract models of computing capable of recognizing those languages, and the grammar used to generate them.
- 325: Advanced Data Structures and Algorithms.** 0-3-3. Preq., CSC 220. Advanced data structures and algorithm design. Topics include specialized trees, graphs, sets and tables, advanced searching and sorting, complexity analysis, and algorithm design techniques.
- 330: Programming Languages.** 0-3-3. Preq., CSC 240, 325. Techniques for specifying the syntax and semantics of programming languages. Language concepts; execution environments; comparative analysis of programming languages.
- 345: Operating Systems.** 0-3-3. Preq., CSC 240 & 265. An introduction to operating systems concepts. Topics include processor management, storage management, device management, performance, security, and case studies of common operating systems.
- 364: Computer Architecture.** 0-3-3. Preq., CSC 265 & 269. Architecture and organization of computer systems. Topics include the processor, control unit and microprogramming, computer arithmetic, memory hierarchy and memory management, input/output, instruction sets.
- 404: Senior Capstone.** 0-3-3. Preq., CSC 325 & senior standing. This course provides a forum for discussion of the social and ethical aspects of computing. Communication skills will be emphasized through professional presentations and formal written essays.
- 419: Special Topics in Theory of Computing.** 0-3-3. Preq., consent of instructor. Selected topics in the area of computing theory that are of current importance or special interest.
- 420: Design and Analysis of Algorithms.** 0-3-3. Preq., CSC 325 or consent of instructor. Design and analysis of efficient algorithms. Topics include complex data structures, advanced searching and sorting, algorithm design techniques, and complexity analysis.
- 425: Discrete Mathematics, Data Structures and Algorithms.** 0-4-4. Preq., Consent of instructor (cannot be applied for credit toward any Computer Science degree). Mathematical foundations of computer science; definition, application and implementation of abstract data types; algorithm design and analysis techniques. (G)
- 429: Special Topics in Software Development.** 0-3-3. Preq., consent of instructor. Selected topics in the area of software design that are of current importance or special interest.
- 430: Database Management Systems.** 0-3-3. Preq., CSC 325 or consent of instructor. Database concepts, organizations and applications; database management systems; implementation of a simple database. (G)
- 436: Compiler Design.** 0-3-3. Preq., CSC 310, 330 or consent of instructor. Principles of compiler design; assembler design; lexical analysis; syntax analysis; automatic parser generations; error detection and recovery. (G)
- 437: Programming Language Paradigms and Software Development.** 0-4-4. Preq., CSC 425 and consent of instructor (cannot be applied for credit toward any Computer Science degree). Imperative, functional, logical and object-oriented paradigms; programming language semantics and language translation; specification, design, implementation, validation, and maintenance of large software systems. (G)
- 439: Special Topics in Programming Environments.** 0-3-3. Preq., consent of instructor. Selected topics in the area of programming environments that are of current importance or special interest.
- 445: Architecture and Operating Systems; Parallel Computing.** 0-4-4. Preq., CSC 425 and consent of instructor (cannot be applied for credit toward any Computer Science degree). Digital logic, instruction set architectures, microprocessor design; storage management, process synchronization and communications, device management; introduction to parallel architectures, languages and algorithms. (G)
- 449: Special Topics in Operating Systems.** 0-3-3. Preq., consent of instructor. Selected topics in the area of operating systems that are of current importance or special interest.
- 450: Computer Networks.** 0-3-3. Preq., CSC 345 or consent of instructor. An overview of computer networks. Topics include network topologies, layers, local area networks, and performance measurement and analysis. (G)
- 464: Advanced Digital Design.** 0-3-3. Preq., CSC 265. Synchronous sequential circuits, FSM optimization and implementation, testing, level-mode sequential design, race and hazards, advanced ALU, programmable logic devices, CAD tools and HDLs.

466: Microprocessor Systems Design. 0-3-3. Preq., CSC 364. Microprocessor-based system design, bus design, memory systems, input/output interfacing and DMA, microprocessor-based laboratory project.

468: Introduction to VLSI. 0-3-3. Preq., CSC 265. VLSI design methodologies, fabrication and layout, combinational and sequential design in VLSI, subcell design, system design, advanced design techniques.

469: Special Topics in Computer Architecture. 0-3-3. Preq., consent of instructor. Selected topics in the area of computer architecture that are of current importance or special interest.

470: Computer Graphics. 0-3-3. Preq., CSC 325 or consent of instructor. Fundamentals of two and three dimensional computer graphics. Topics include line drawing, polygon rendering, clipping algorithms, two and three dimensional transformations, and projection techniques. (G)

472: Human-Computer Interface. 0-3-3. Preq., CSC 230 and 325. Theory, design, and implementation of graphical human-computer interface strategies. Topics include interface layout, visualizing knowledge, comparison of user interfaces, and hypertext/hypermedia.

475: Artificial Intelligence. 0-3-3. Preq., CSC 330 or consent of instructor. The design and implementation of artificially intelligent programs. Topics include game playing, heuristic search, logic, knowledge representation, and reasoning strategies. Social implications are also discussed. (G)

479: Special Topics in Computer Applications. 0-3-3. Preq., consent of instructor. Selected topics in the area of computer applications that are of current importance or special interest.

490: Applied Computing Project. 1-3 hours credit. Preq., junior standing in Computer Science or equivalent. Independent investigation of a problem in computing.

499: Special Topics in Computer Science. 0-3-3. Preq., consent of instructor. Selected topics of current importance or special interest.

505: Expert Systems. 0-3-3. Preq., CSC 475 or consent of instructor. Current topics in expert system design, knowledge acquisition, explanation generation and knowledge representation. A substantial expert system design, implementation and testing project is required.

512: Programming Language Semantics. 0-3-3. Preq., CSC 310 or CSC 436 or consent of instructor. Syntax specification using attribute grammars and two level grammars, operational semantics, translational semantics, formal semantic techniques such as denotational semantics, algebraic specification, and axiomatic semantics.

520: Advanced Analysis of Algorithms and Complexity. 0-3-3. Preq., CSC 420 or consent of instructor. Formal analysis of time and space requirements of various algorithms, greedy algorithms, divide-and-conquer, dynamic programming, P and NP algorithms; Turing machines and unsolvability.

521: Advanced Computer Architectures. 0-3-3. Preq., CSC 364. Topics include: pipeline systems design, processor design techniques (concepts, analysis, performance comparison, implementation, commercial processors), memory system design, interconnection media.

530: Database Theory. 0-3-3. Preq., CSC 430 or consent of instructor. Data models, relational algebra and relational calculus, data dependencies and schema normalization, Datalog, recovery and concurrency control, distributed database environments.

532: Advanced Topics in Software Engineering. 0-3-3. Preq., CSC 230 or consent of instructor. Readings in requirements analysis, formal specification techniques, software design techniques, CASE tools, software metrics, software verification and validation, quality assurance and software safety.

534: Performance Measurement and Evaluation. 0-3-3. Preq., CSC 345 or consent of instructor. Computer systems performance; analysis techniques; data acquisition methods; simulation techniques; interpretation of results.

541: High Performance Computer Architecture. 0-3-3. Preq., CSC 364. Topics include: principles of scalable performance, multiprocessor system design, message-passing systems, vector computers, data flow computers, and multithreaded architecture.

550: Special Problems. 1-4 semester hour credit. Individual research and investigation of a problem in computer science or computing practice.

551: Research and Thesis in Computer Science. Registration in any quarter may be for three semester hours credit or multiples thereof. Maximum credit allowed is six semester hours.

554: Advanced Networking. 0-3-3. Preq., CSC 450 or consent of instructor. May be repeated with change in subject matter. Selected research topics of current interest in the field of computer communications and networks.

555: Practicum. 0-3-3 Maximum credit allowed is three semester hours. Preq., 12 semester hours of graduate work. Analytical and/or experimental solution of a problem in computer science; technical literature survey required; development of a computer-based solution.

557: Special Topics: Computer Science. 0-3-3 (9). The topic or topics will be selected by the instructor from the various sub-areas of computer science. May be repeated as topics change.

570: Advanced Topics in Computer Graphics. 0-3-3. Preq., CSC 470 or consent of instructor. Techniques used to produce realistic images of three-dimensional objects on computer graphics hardware. Topics include: reflection models, shading techniques, ray tracing, texture and animation.

575: Advanced Topics in Artificial Intelligence. 0-3-3. Preq., CSC 475 or consent of instructor. Advanced topics in artificial intelligence including: problem-solving systems, natural language understanding, intelligent tutoring systems, learning and neural networks.

581: Parallel Algorithms. 0-3-3. Preq., CSC 240. Models of parallel computers, basic communications operations, algorithms for searching, sorting, graph structures, and systolic systems, dynamic programming, performance and scalability of parallel systems.

582: Parallel Computational Methods. 0-3-3. Preq., CSC 240, MATH 415. Parallel implementations of FFT, interpolation, integration, Eigensystems, matrix maximization, ODEs, PDEs.

583: Computational Solutions for PDE I. 0-3-3. Preq., MATH 414. Finite difference schemes and their accuracy, stability, and convergence. Schemes for parabolic and hyperbolic PDEs. Emphasis on program implementation.

584: Computational Solutions for PDE II. 0-3-3. Preq., CSC 583 or MATH 574. Finite difference schemes for elliptic PDEs, iterative methods, and introduction to finite element methods and multigrid methods. Emphasis on program implementation.

COUNSELING (COUN)

400: Introduction to Counseling. 0-3-3. Introductory course for professional workers. Includes purposes and scope of counseling service, concepts, principles and basic techniques of counseling. (G)

401: Student Personnel Services. 0-3-3. A study of student personnel programs in colleges and universities. This course may not be taken for graduate credit.

460: Behavioral Counseling. 0-3-3. A non-cognitive approach to counseling that presents the necessary attitudes, concepts, principles, and skills for individual counseling.

500: Principles and Administration of Guidance Services. 0-3-3. An overview of the current principles and practices involved in various types of guidance and counseling services.

505: Analysis of the Individual. 3-2-3. Preq., PSYC 542 or equivalent. This course offers students an orientation to psychological testing procedures, their interpretation, evaluations and use in the understanding of clients.

506: Introduction to Rehabilitation Counseling. 0-3-3. Philosophical, social, psychological and legislative bases of rehabilitation; nature and scope of the process and functions of rehabilitation counselors.

507: Case Management in Rehabilitation Counseling. 0-3-3. Development of case management in procedures and skills: integration of theory and practice.

508: Introduction to Counseling Theories. 0-3-3. A detailed study of a selection of the best known schools of counseling theory.

510: Counseling the Elderly. 0-3-3. Dynamic and therapeutic models for counseling the aged and their families; focus on matching interventions to lifestyles.

512: Counseling the College Student. 0-3-3. An emphasis on development in young adulthood; historical, philosophical, and practical aspects of personnel services for college students.

513: Career Information and Career/Life Style Development. 0-3-3. Provides an understanding of career development; occupational/educational information sources and systems; career and lifestyle counseling; career decision-making and instruments relevant to career planning.

514: Career Education: Vocational Guidance. 0-3-3. A course in career guidance designed to provide an overview of career development and its applications within the high school setting.

515: Career Education: Orientation of the World of Work. 0-3-3. A course in career guidance designed to provide an overview of career development and its applications within the elementary school setting.

- 516: An Introduction to Group Processes.** 0-3-3. Preq., COUN 508. Emphasis is on providing students with a knowledge of group dynamics, and learning basic group counseling techniques under supervision.
- 518: Techniques of Counseling.** 3-2-3. Preq., COUN 508. Provides an overview of counseling techniques and interview methods.
- 520: Case Studies in Counseling.** 1-3 hours credit. Preq., COUN 508 and consent of instructor. Preparation and use of case studies in counseling.
- 521: Seminar: Current Psychological Literature.** 1-3 hours credit. May be repeated. Preq., COUN 508 and consent of instructor. Students are required to do extensive reading on selected topics in psychology.
- 522: Field Work in Counseling.** 3 hours credit (6). Preq., COUN 518 and consent of instructor. Supervised study, observation, and practice in selected employment settings.
- 523: Elementary School Guidance.** 0-3-3. A review of the principles and organizational patterns of guidance services at the elementary school level.
- 525: Advanced Techniques of Counseling.** 3-2-3. Preq., COUN 518 and consent of instructor. Further experiences in advanced counseling techniques appropriate to various counseling theories.
- 526: Problems in Guidance.** 3 hours credit (6). Special conferences, workshops, and seminars as requested by elementary and secondary school personnel. May be repeated for a maximum of 6 hours credit.
- 527: Addiction Counseling.** 0-3-3. An introduction to the field of Addiction Counseling. Emphasis is placed on recognition and identification of the addicted as well as basic treatment techniques.
- 528: Advanced Addiction Counseling.** 3-2-3. Preq., COUN 527. A methods course intended to equip the student with a basic conception of various therapeutic modalities.
- 529: Cross-cultural Counseling.** 0-3-3. Investigation of the development of cultural identity and techniques for appropriate interactions with clients from different cultural groups.
- 530: Practicum.** 5-1-3. Open only by application. Supervised professional activity in the student's major field. (Minimum 3.0 GPA required)
- 531: Internship.** 20-1-3 (6). Preq., COUN 530 or equivalent and permission of adviser. Advanced supervised counseling practice in a setting appropriate to the student's professional development.
- 532: School Counseling Practicum.** 5-1-3. Open only by application. Supervised professional activity in a school setting. (Minimum 3.0 GPA is required)
- 590: Ethics and Professional Practice.** 0-3-3. Preq., COUN 508. An in-depth investigation of ethical and legal issues, as well as technical concerns, related to the professional practice of counseling.

ECONOMICS (ECON)

- 201: Economic Principles and Problems.** 0-3-3 each. A study of basic economic principles and problems, with particular reference to the operation and social implications of the American economic system. (201-Macro).
- 202: Economic Principles and Problems.** 0-3-3 each. A study of basic economic principles and problems, with particular reference to the operation and social implications of the American economic system. (202-Micro).
- 215: Fundamentals of Economics.** 0-3-3. (Not open to students who have had ECON 201-202.) A survey of the major principles of economics designed for the student whose curriculum requires only one quarter of economic principles.
- 312: Monetary Economics.** 0-3-3. Preq., ECON 202 or 215. A study of the causes of changes in the supply of money and rate of spending and the effects of these changes on production, employment and the price level.
- 344: International Economics.** 0-3-3. Preq., ECON 201 or 215 or consent of instructor. Introduction to modes of business operations and the economic factors which affect international trade. Study of principles, practices, and theory of how and why nations trade.
- 401: Internship in Economics I.** 3 hours credit. (Pass/Fail) Preq. consent of instructor and senior standing. On site, supervised, structured work experiences in the field of business.
- 402: Internship in Economics II.** 3 hours credit. (Pass/Fail) Preq. consent of instructor and senior standing. On site, supervised, structured work experiences in the field of business.
- 403: Economics of Industrial Organization.** 0-3-3. Preq., ECON 202 or 215. Relationships between structure, conduct and performance of industries using theoretical and empirical material: Antitrust and environmental regulation, R&D, product advertising and pricing are examined. (G)

- 406: Comparative Economic Systems.** 0-3-3. Preq., ECON 202 or 215. A study of alternative economic systems such as capitalism, socialism, communism, and "mixed" in theory and practice.
- 408: Intermediate Economic Theory.** 0-3-3. Preq., ECON 202 or 215, or consent of instructor. Microeconomics; intensive study of price, production, and distribution theories. (G)
- 409: Managerial Economic Analysis.** 0-3-3. Preq., senior standing or consent of instructor. Lectures and cases emphasizing economic principles as used in managerial decision-making. Includes analysis of demand, cost and price relationships, price decision, risk and uncertainty, and capital investment. (G)
- 410: Public Finance.** 0-3-3. Preq., ECON 202 or 215. An introduction to the principles and theory of financing local, state, and federal governments.
- 418: Labor Economics.** 0-3-3. Preq., ECON 202 or 215 or consent of the instructor. Fundamentals of labor market operations, economic analysis of labor legislation; impact of American unions upon the firm's decision making and the national economy. (G)
- 437: Aggregate Economic Analysis.** 0-3-3. Preq., ECON 312. Macroeconomics; intensive study of economic theory of national income analysis, interest, employment, and fiscal policy. (G)
- 510: Managerial Economics.** 0-3-3. Analysis and cases; actual case studies in the application of price and distribution theory to problems of the firm.
- 512: Current Economic Policies.** 0-3-3. An investigation of modern economic concepts in the United States through a study of policies advanced by various economic groups tending to shape economic action.
- 513: Macroeconomic Theory I.** 0-3-3. Preq., ECON 437 or other acceptable background course(s). Analysis of monetary factors and government revenue-expenditure factors affecting the general level of prices, investment decisions, interest rates, national income and employment.
- 520: Advanced Microeconomic Theory.** 0-3-3. Preq., ECON 408 or other acceptable course(s). Value and distribution theory emphasizing applications to business operations and public policy issues.
- 532: Econometric Methods.** 0-3-3. Preq., QA 432 or other acceptable courses. The use of statistical techniques in economic research including estimation and interpretation of parameters of economic models.
- 540: Macroeconomics: Business Conditions Analysis.** 0-3-3. Preq., ECON 510. Detailed review of techniques, procedures and data sources used by business economists to gather, analyze, interpret, and forecast macroeconomic variables.
- 541: Microeconomics: Business Conditions Analysis.** 0-3-3. Preq., ECON 510. Detailed review of techniques, procedures, and data sources used by business economists to gather, analyze, interpret and forecast microeconomic variables.
- 542: Seminar on Business Economics Problems.** 0-3-3. Preq., ECON 510 or equivalent or consent of instructor. Students will develop and present an analytical study in micro- or macroeconomics in a form expected of a business economist's presentation to corporate management.
- 550: Directed Study in Economics.** 1-3 hours credit. Hours and credits to be arranged. Consent of instructor and approval of department head required. Special problem or specific area of economics.
- 613: Macroeconomic Theory I.** 0-3-3. Preq., ECON 437 or other acceptable background course(s). Requires Doctoral standing. May require additional class meetings. Analysis of monetary factors and government revenue-expenditure factors affecting the general level of prices, investment decisions, interest rates, national income and employment. Credit will not be given for ECON 613 if credit is given for ECON 513.
- 620: Advanced Microeconomic Theory.** 0-3-3. Preq., ECON 408 or other acceptable course(s). Requires Doctoral standing. May require additional class meetings. Value and distribution theory emphasizing applications to business operations and public policy issues. Credit will not be given for ECON 620 if credit is given for ECON 520.
- 632: Econometric Methods.** 0-3-3. Preq., QA 432 or other acceptable courses. Requires Doctoral standing. May require additional class meetings. The use of statistical techniques in economic research including estimation and interpretation of parameters of economic models. Credit will not be given for ECON 632 if credit is given for ECON 532.
- 641: Microeconomics: Business Conditions Analysis.** 0-3-3. Preq., ECON 510. Requires Doctoral standing. May require additional class meetings. Detailed review of techniques, procedures, and data sources used by business economists to gather, analyze, interpret and forecast microeconomic variables. Credit will not be given for ECON 641 if credit is given for ECON 541.