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Undergraduate Bulletin



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## Course Descriptions - Chemical Engineering

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### CHE 110 Programming and Computation for Chemical Engineers 2R-0L-2C S Pre: None

An introduction to problem solving and programming using spreadsheets and Visual Basic for Applications (VBA). Spreadsheet applications include graphical analysis, curve-fitting, parameter estimation, numerical differentiation and integration, solution of systems of algebraic (linear and nonlinear) equations and ordinary differential equations. VBA programming topics include structured and object-oriented programming concepts as well as applications involving the creation of customized worksheet functions.

### CHE 200 Career Preparation I 0L-0C F Pre: sophomore standing in Chemical Engineering

Career choices in chemical engineering, internship, coop, chemical industry working environment. 2-5 contact hours per quarter.

### CHE 201 Conservation Principles and Balances 4R-0L-4C F Pre: CHEM 113, MA 113 and PH 111

An introduction to engineering calculations, the use of common process variables, and conservation and accounting of extensive properties - mass, energy, charge, linear momentum - as a common framework for engineering analysis and modeling. Applications of conservation of mass and energy in analysis of chemical engineering processes will be addressed including recycle, bypass and multi-stream processes. There will be an introduction to equipment, flowcharts, techniques and methodologies used by practicing chemical engineers. The use of computer software, especially spreadsheets, will be integrated into the course.

### CHE 202 Basic Chemical Process Calculations 4R-0L-4C W Pre: CHE 201

Applications of the principles of conservation of mass and energy to reactive, multiphase, and transient systems. The course continues to develop concepts from CHE 201 and provides a more extensive treatment of energy balances.

### CHE 300 Career Preparation II 0L-0C W Pre: Junior standing in Chemical Engineering

Career choices; preparation of resume; preparation for summer positions; preparation for graduate programs. 2-5 contact hours per quarter.

### CHE 301 Fluid Mechanics 4R-0L-4C F,S Pre: CHE 201

Physical properties, fluid statics, laminar and turbulent flow of real fluids, boundary layer concept, interaction between fluid flow and contacting surfaces. Use of energy balances in design of pipe networks and pumps. Emphasis is placed on general methods of analysis applicable to any fluid. Solution of problems by computer will be stressed.

### CHE 303 Chemical Engineering Thermodynamics 4R-0L-4C F,S Pre: CHE 201, MA221

First and second laws of thermodynamics and their application including thermodynamic cycles, closed and open systems. Thermodynamic properties of pure components. Phase equilibria of pure components. Equations of state, state diagrams. Thermodynamic analysis of processes.

### CHE 304 Multi-Component Thermodynamics 4R-0L-4C F, W Pre: CHE 303, MA222

Properties of mixtures. Phase equilibria for mixtures. Equations of state and

activity coefficient models. Chemical reaction thermodynamics. Thermodynamic analysis of processes. Project based study of phase equilibria involving the use of a process simulator.

**CHE 314 Heat Transfer 4R-0L-4C F, W, Pre: CHE 202, CHE 301, MA221**

Discussion of fundamental heat transfer processes: conduction, forced and free convection, boiling and condensation, and radiation heat transfer. Mathematical analysis and computation of heat transfer and temperature profiles in solids with simple geometry. Estimation of local and overall heat transfer coefficients. Use, design, and selection of heat exchangers and heat exchange systems for various applications in the chemical process industries.

**CHE315 Materials Science and Engineering 4R-0L-4C F Pre: CHEM 113**

Introduction to the properties and processing of metals, ceramics, polymers, and semiconductors. The influences of crystal structure, interatomic bonding, and electronic structure on physical, mechanical, and electrical properties are emphasized. Causes and mitigation of various types of corrosion are explored. Properties and design of composite materials are introduced.

**CHE 325 Mass Transfer 4R-0L-4C W, S Pre: CHE 202, CHE 314, CHE 304**

Principles of diffusion. Study of gas-liquid operations including gas absorption and distillation in equilibrium stage tray columns as well as packed columns. Quantitative treatment of mass transfer based on material and energy balances, phase equilibrium and rates of heat and mass transfer.

**CHE 385 Quality Methods 4R-0L-4C S Pre: MA 223 or MA 381 and consent of instructor (See MA 385.)**

Introduction to various aspects of statistical quality control and statistical process control to include the following topics: importance of variance reduction and probability concepts influencing product quality and reliability; development and application of control charts (P-charts, NP-chart, C-charts, U-charts, Individuals Charts, moving range charts, X-bar and R as well as X-bar and S charts); process capability indices (their use and misuse); introduction to acceptance sampling. Other topics to be included as time allows: 6 sigma thinking, gauge reproducibility and repeatability, and total quality management with the philosophies of Deming, Juran, and Crosby. Review of fundamental prerequisite statistics will be included as necessary.

**CHE 404 Kinetics and Reactor Design 4R-0L-4C F,S Pre: CHEM 360 and CHE 304**

Homogeneous kinetics, differential and integral data analysis, batch, mixed, and plug flow reactors, systems with multiple reactions and reactors, temperature and pressure effects.

**CHE 405 Introduction to MEMS: Fabrication and Applications 3R-3L-4C S Pre: JR or SR Standing (See PH 410/510.)**

Properties of silicon wafers, wafer-level processes, surface and bulk micromachining, thin-film deposition, dry and wet etching, photolithography, process integration, simple actuators. Introduction to microfluidic systems. MEMS applications: capacitive accelerometer, cantilever and pressure sensor. Students enrolled in CHE 405/505 must do project work on a topic selected by the instructor.

**CHE 409 Professional Practice 1R-0L-1C F**

Topics on professional practice, project management, contemporary and global issues in the profession are discussed by students, staff and outside speakers.

**CHE 410 Data Collection, Analysis and Interpretation 2R-0L-2C S and/or F Pre: CHE 202, MA 223, RH 330**

An introduction to laboratory concepts in data collection, record keeping, interpretation and analysis, and instrumentation. Topics include experimental error analysis, regression, model formulation, experimental design, and

instrumentation. In addition, students will be formally instructed on written and oral communication and teaming.

**CHE 411 Chemical Engineering Laboratory I 0R-3L-1C S Pre: CHE 202, CHE 314, MA223**

Principles underlying momentum, mass and energy transfer and the applications of equipment used to accomplish such transfer. Written and oral reports are required.

**CHE 412 Chemical Engineering Laboratory II 0R- 6L-2C F Pre: CHE 325, CHE 410, CHE 411 or consent of instructor**

Continuation of CHE 411.

**CHE 413 Chemical Engineering Laboratory III 0R- 6L-2C W Pre: CHE 412**

Continuation of CHE 412 with emphasis on process control and kinetics.

**CHE 416 Design I: Process Economics and Equipment Design 4R-0L-4C F Pre: CHE 325, CHE 404 or concurrent registration**

Introduction to the design process; simulation to assist in process creation & analysis; synthesis of separation trains; design of separation towers, heat exchangers, pumps, compressors, expanders and other process equipment; cost accounting & capital cost estimation, trade-offs between capital and operating costs; design of reactor-separator-recycle networks.

**CHE 417 Design II: Process Synthesis and Analysis 4R-0L-4C W Pre: CHE 416, CHE 404**

Annual costs, earnings & profitability; process creation, optimization of process flowsheets; molecular structure design; heat & power integration; mass integration; optimal design & scheduling of batch processes. The course includes an open-ended process improvement project.

**CHE 418 Design III: Capstone Design Project 0R-6L-2C S Pre: CHE 417**

Completion of an open-ended design project which will include written and oral communication of intermediate status and the final design specifications.

**CHE 419 Advanced MEMS: Modeling and Packaging 3R-3L-4C F Pre: PH410 or equivalent (See PH 411/511.)**

Design process, modeling; analytical and numerical. Actuators; dynamics and thermal issues. Use of software for layout and simulation. Characterization and reliability of MEMS devices. Electrical interfacing and packaging of MEMS. Microsensors, microfluidic systems, applications in engineering, biology, and physics. Students enrolled in CHE 419/519, must do project work on a topic selected by the instructor.

**CHE 420 Consulting Engineering Seminar 2R-0L-2C Pre: Junior class standing**

Discusses problems in the field of consulting engineering. Seminars presented by practicing consulting engineers.

**CHE 440 Process Control 4R-0L-4C W Pre: CHE 202, MA222**

The mathematics of process dynamics, control system design, Laplace transforms, feedback control theory, characteristics of control elements, stability criteria, and frequency response. The course at times uses a personalized system of instruction format.

**CHE 441 Polymer Engineering 4R-0L-4C F Pre: CHE 404 or concurrent registration in CHE 404 or consent of instructor**

Interrelation of polymer structure, properties and processing. Polymerization kinetics. Methods for molecular weight determination. Fabrication and processing of thermoplastic and thermosetting materials. Student projects.

**CHE 450 Air Pollution Control 4R-0L-4C F or W Pre: Junior or Senior standing**

An introduction to air pollution and its control with special emphasis on the

engineering aspects. Discussions of meteorology, health effects, sources and types of pollution, industrial control technology. Student projects. Cross-listed with CE561.

**CHE 461 Unit Operations in Environmental Engineering 4R-0L-4C F or W Pre: EM 301 or CHE 301**

Physical-chemical unit operations pertinent to wastewater treatment such as membrane separations, filtration, coagulation, flocculation, ion exchange, carbon adsorption. Applications for unit operations from the chemical process industries are also covered. Cross-listed with CE563.

**CHE 470 Safety, Health, and Loss Prevention 4R-0L-4C S Pre: Junior or Senior standing**

Fundamentals of chemical process safety including toxicology, industrial hygiene, toxic release and dispersion models, fires and explosions, HAZOP analysis. Design of equipment to prevent fires and explosions. Risk assessment, including event and fault trees.

**CHE 490 Special Topics in Chemical Engineering 4R-0L-4C F, W, S**

Topics of current interest in chemical engineering.

**CHE 499 Directed Research F, W, S Pre: Permission of instructor**

A special project is assigned to or selected by the student. The publication of research is encouraged. Variable credit. May be repeated up to a maximum of eight credits.

**UNDERGRADUATE-GRADUATE COURSES**

**CHE 502 Transport Phenomena I 4R-0L-4C Pre: CHE 325 or consent of instructor**

Solution of the equations of change for momentum, energy, and mass transport. Mathematical determination of velocity profiles and momentum flux for isothermal flows inside ducts and over objects in both steady and unsteady systems. Turbulent flow theories. Mathematical determination of temperature profiles and heat flux, and concentration profiles and mass flux, in solids and laminar flows including boundary layers. Theoretical bases for friction factors, convective heat transfer, and convective mass transfer coefficients. Dimensional analysis.

**CHE 503 Transport Phenomena II 4R-0L-4C**

Energy Transport: multidimensional systems; macroscopic balances for nonisothermal systems. Mass Transport: fundamentals of ordinary diffusion, multicomponent diffusion, pressure and thermal diffusion, coupled heat and mass transfer, boundary layer analysis, turbulent transport, mass transfer coefficients, macroscopic balances.

**CHE 504 Advanced Reactor Design 4R-0L-4C W Pre: CHE 404**

Strategies for modeling the effects of real reactor systems, including non-ideal flow and multiple phases. Applications in catalysis, combustion, biotechnology, polymerization, and materials processing. Computer methods and software for reactor engineering.

**CHE 505 Introduction to MEMS: Fabrication and Applications 3R-3L-4C S Pre: JR or SR standing**

Properties of silicon wafers; wafer-level processes, surface and bulk micromachining, thin-film deposition, dry and wet etching, photolithography, process integration, simple actuators. Introduction to microfluidic systems. MEMS applications: capacitive accelerometer, cantilever and pressure sensor.

Students enrolled in PH510, ME516, ECE516, CHE505, BE516 must do project work on a topic selected by the instructor.

**CHE 512 Petrochemical Processes 4R-0L-4C F or W Pre: CHE 325 or consent of instructor**

Multicomponent separation of petroleum by flash vaporization and by

distillation. Catalytic processes for production of light petroleum products from heavier derivatives. Production of petrochemicals such as ethylene, methanol, and ammonia from natural gas. Group projects on refinery and petrochemical processes. Material balances and economic evaluations. Application of computer design packages and spreadsheets.

**CHE 513 Advanced Chemical Engineering Thermodynamics 4R-0L-4C  
Pre: CHE 304**

Review of thermodynamic principles including fundamental equations and the laws of thermodynamics. Thermodynamics of mixtures, phase equilibria, and thermodynamic analysis of processes. Project based in-depth study of phase equilibria, equations of state, and activity coefficient models. Use of process simulator for phase equilibria calculations. Introduction to statistical thermodynamics.

**CHE 519 Advanced MEMS: Modeling and Packaging 3R-3L-4C F Pre:  
PH410 or equivalent course**

Design process, modeling; analytical and numerical. Actuators; dynamics and thermal issues. Use of software for layout and simulation. Characterization and reliability of MEMS devices. Electrical interfacing and packaging of MEMS. Microsensors, microfluidic systems, applications in engineering, biology, chemistry, and physics.

Students enrolled in PH511, ME519, ECE519, CHE519, BE519 must do project work on a topic selected by the instructor.

**CHE 521 Advanced Chemical Engineering Computation 4R-0L-4C**

The application of advanced mathematics to chemical engineering problems. The topics include: the formulation of the partial differential equations of kinetics and heat, mass and momentum transfer problems; series solution techniques; transform solution techniques; vector formulation; numerical methods for systems of differential equations; optimization, including linear programming, combinatorial optimization, and stochastic optimization techniques.

**CHE 540 Advanced Process Control 4R-0L-4C Pre: CHE 440 and consent  
of instructor**

Control topics beyond those covered in CHE 440. Topics will be selected from among the following: optimization, nonlinear control, adaptive control, multivariable systems, process dynamics, digital systems, system design.

**CHE 545 Introduction to Biochemical Engineering 4R-0L-4C Pre: CHE  
404 or AB421 or consent of instructor**

Survey course introducing biochemical terminology and processes. Review of microbiology and biochemistry. Enzyme kinetics, cellular genetics, biochemical transport phenomena, and design and operation of biochemical reactors. Emphasis on applying engineering principles to biochemical situations.

**CHE 546 Bioseparations 4R-0L-4C, Pre: CHE 325 or consent of instructor**

An introduction to biochemistry and microbiology will be followed by analysis of bioseparation processes. Filtration, centrifugation, adsorption, electrophoresis, and chromatography are the primary topics of the course. Applications are emphasized.

**CHE 590 Special Topics in Chemical Engineering 4R-0L-4C F, W, S**

Topics of current interest in chemical engineering. May be repeated.

**CHE 597 Special Projects in Chemical Engineering F, W, S Pre:  
Permission of instructor**

A special project, or series of problems, or research problem is assigned to or selected by the student. A comprehensive report must be submitted at the conclusion of the project. Not to be used as a substitute for CHE 599, Thesis Research. Variable credit. May be repeated up to a maximum of eight credits.



**CHE 598 Graduate Seminar 1R-0L-0C F, W, S**

Selected topics in chemical engineering are discussed by graduate students, faculty, and guest speakers.

**CHE 599 Thesis Research F, W, S**

Graduate students only. Credits as assigned; however, not more than 12 credits will be applied toward the requirements of the M.S. degree.