

**CHEMICAL & BIOMOLECULAR ENGINEERING DEPARTMENT  
UNDERGRADUATE PROGRAM**

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**CHEE 2331 – CHEMICAL PROCESSES**

Minimum Course Content:

- Introduction to Chemical Engineering and Engineering Calculations
- Processes and Process Variables
- Fundamentals of Material Balances
- Single-Phase Systems
- Multiphase Systems
- Energy and Energy Balances
- Balances on Nonreactive Processes
- Balances on Reactive Processes

**Textbook suggested:**

Richard M. Felder, Ronald W. Rousseau, and Lisa G. Bullard, **Elementary Principles of Chemical Processes**, 4<sup>th</sup> edition, John Wiley & Sons, 2016.

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**CHEE 2332 – THERMODYNAMICS I**

Minimum Course Content:

- Introduction, volumetric properties of pure substances, equations of state and thermodynamic tables.
- First law and other basic concepts such as energy, heat and work, mass and energy balances, closed and open systems.
- Second law of thermodynamics, Carnot engines, concept of entropy, entropy balance, and thermometry.
- Thermodynamic properties of simple fluids, heat effects, phase changes, vapor pressure equations, real fluid properties.
- Thermodynamics of flow processes, throttling, turbines, compressors, pumps, efficiencies.
- Power and refrigeration cycles.

**Textbooks suggested:**

M. T. Fleischer, Thermodynamics: Fundamentals and Applications for Chemical Engineers, Second Edition, Cognella, 2018 (ISBN: 978-1-5165-2669-7).

Introduction to Chemical Engineering Thermodynamics, 7th ed., (2005) by J. M. Smith, H. C. Van Ness and M. M. Abbott (ISBN: 0-07-310445-0).

Athanassios Panagiotopoulos, *Essential Thermodynamics*, Drios Press, Princeton, NJ.

**Reference book suggested:**

Daniel A. Crowl and Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall, 3<sup>rd</sup> Edition, 2011 (ISBN: 978-0-13-138226-8).

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## **CHEE 3300 – MATERIALS SCIENCE**

Minimum Course Content:

- Introduction
- Atomic structure, energy levels and chemical bonds in solids
- Crystal structure and defects
- Diffusion in solids
- Mechanical properties of materials stress, strain, deformation, slip, yield, fracture
- Phase diagrams
- Kinetics of phase transformations
- Ceramics - crystal structure, phase diagrams, mechanical properties
- Polymers - polymerization, molecular structure, , semi-crystalline structure, melting and crystallization, glass transition, mechanical behavior
- Electronic materials - energy bands and band gaps, conduction, semiconductors, dopants, carrier mobility, P-N junctions, transistors
- Materials selection

Other Suggested Topics:

- Corrosion
- Cold working and heat treatment of metals, alloys
- Advanced topics in polymers
- Advanced topics in ceramics
- Advanced topics in electronic materials
- Advanced topics in optical materials

**Textbook suggested:**

William D. Callister, Jr. and David G. Rethwisch, **Materials Science and Engineering: An Introduction**, 9<sup>th</sup> edition, J. Wiley and Sons, 2014.

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## **CHEE 3321 – ANALYTICAL METHODS FOR CHEMICAL ENGINEERS**

Minimum Course Content:

- Introductory concepts: Mathematical Modeling
  - First-order differential equations & modeling concepts
  - Second- and higher-order differential equations and models
  - Linear algebra and applications
  - Introduction to partial differential equations and models
  - Chemical Engineering applications (for all topics)
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## **CHEE 3333 – CHEMICAL ENGINEERING THERMODYNAMICS II**

Minimum Course Content:

- Introduction to thermodynamics of multicomponent-multiphase systems
- Partial quantities, Chemical potential and criterion for equilibrium
- Raoult's law for an ideal system
- VLE calculations for an ideal system
- Equilibrium flash calculations for ideal systems
- Modified Raoult's law and flash calculations for non-ideal systems.
- Fugacity and fugacity coefficients
- Ideal Solutions, excess properties and activity coefficient
- Liquid Phase properties from VLE data.
- Discussion of models for activity coefficients
- Heat effects of mixing.
- The Gamma/Phi Formulation of VLE
- Equilibrium and Stability
- Liquid-liquid equilibrium
- Introduction to chemically reacting systems and chemical equilibria
- Equilibria of single reaction systems
- Equilibria of multiple reaction systems

### **Textbook suggested:**

J. M. Smith, H. C. Van Ness and M. M. Abbot, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill, 2005.

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## **CHEE 3334 – NUMERICAL & STATISTICAL METHODS**

Minimum Course Content:

- Introduction to computers and numerical methods
  - Linear algebraic equations
  - Nonlinear algebraic equations
  - Numerical integration and differentiation
  - Ordinary differential equations
  - Partial differential equations
  - Probability and Statistics
  - Statistical calculations
  - Statistical process control
  - Design of experiments
  - Critical assessment of statistical arguments
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## **CHEE 3363 – FLUIDS MECHANICS FOR CHEMICAL ENGINEERS**

Minimum Course Content:

- Introduction to fluid mechanics, units, dimensions, vector analysis review, velocity fields
- Fundamental laws and principles, stress analysis, force on a body, constitutive equations
- Fluid statics and fluids in rigid body motion
- Macroscopic mass and linear momentum equations and applications
- Macroscopic conservation of energy
- Fluid kinematics, differential equations of motion
- Dimensional analysis, correlation of data
- Inviscid flows
- Viscous flows
- External flows, boundary layer theory, momentum integral equations

### **Textbooks suggested:**

Fox, Pritchard, and McDonald, Introduction to Fluid Mechanics, any edition.

### **Reference book suggested:**

Potter, Merle and David C. Wiggert, Schaum's Outline of Fluid Mechanics, 2008, Mc Graw Hill.  
Giles, Ranald V., Schaum's Outline of Fluid Mechanics & Hydraulics, 1994, Mc Graw Hill.

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## **CHEE 3367 – PROCESS DYNAMICS AND CONTROL**

Minimum Course Content:

- Control of a Chemical Process: Characteristics and Associated Problems
  - Modeling the Dynamic and Static Behavior of Chemical Processes
  - Analysis of the Dynamic Behavior of Chemical Processes
  - Analysis and Design of Feedback Control Systems
  - Analysis and Design of Advanced Control Systems
  - Introduction to Plant Control
  - Process Control Using Digital Computers
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## CHEE 3369 – TRANSPORT PROCESSES

Minimum Course Content:

- Foundations of heat transfer
- Steady-state conduction
- Unsteady-state conduction
- Convective heat transfer
- Heat-transfer equipment
- Foundations of mass transfer
- Steady-state molecular diffusion
- Unsteady-state molecular diffusion
- Convective mass transfer
- Interfacial mass transfer
- Mass-transfer equipment

### Textbooks suggested:

J. R. Welty, G. L. Rorrer, and D. G. Foster, **Fundamentals of Momentum, Heat, and Mass Transfer**, 6<sup>th</sup> edition, J. Wiley & Sons, 2014.

### Reference book suggested:

R. B. Bird, W. E. Stewart, and E. N. Lightfoot, **Transport Phenomena**, 2<sup>nd</sup> edition, J. Wiley & Sons Inc., New York, 2002.

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## CHEE 3462 – UNIT OPERATIONS

- Equilibrium stage operation
- Cascades and hybrid systems (includes leaching)
- Mass transfer and diffusion
- Absorption and stripping
- Distillation
- Design / modeling of flow through packed beds, as well as plate columns
- Liquid extraction

### Textbook suggested:

Seader J.D., Henley E.J., and Roper D.K., "Separation Process Principles: Chemical and Biochemical Operations", 3<sup>rd</sup> Ed. 2011, John Wiley & Sons, Inc., ISBN 978-0-470-48183-7

The textbook for this course can be any of many, but must cover principles of mass transfer, as well as separations that include distillation, absorption, stripping, cascades, extraction and membrane separations.

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## **CHEE 3466 – BIOLOGICAL AND PHYSICAL CHEMISTRY**

Minimum Course Content:

- Biomolecules  
amino acids, proteins, carbohydrates, fatty acids, nucleotides, nucleic acids
- Water, weak interactions, acidity and buffers
- Biological applications of thermodynamics
- Chemical and biochemical reaction kinetics  
Mechanisms, equilibrium, entropy and enthalpy of activation, enzyme catalysis, diffusion limited kinetics
- Fundamentals of statistical mechanics

### **Textbook suggested:**

Physical Chemistry: With Applications to the Life Sciences by David S. Eisenberg, Donald M. Crothers  
Addison-Wesley Pub Co; ISBN: 080532402X

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## **CHEE 4321 – DESIGN I**

Minimum Course Content:

- Introduction to Design I
- Engineering ethics
- Teamwork
- Project management
- HS&E
- Process and equipment design
- Process design heuristics
- Capital estimates
- Teams discussions

### **Textbooks suggested:**

*Plant Design and Economics for Chemical Engineers*, Peters, Timmerhaus, and West 5<sup>th</sup> Edition, 2003, McGraw-Hill Book Co., NY, NY, ISBN 0-07-239266-5.

### **Reference book suggested:**

Daniel A. Crowl and Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall, 3<sup>rd</sup> Edition, 2011 (ISBN: 978-0-13-138226-8).

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## **CHEE 4322 – DESIGN II**

Minimum Course Content:

- Introduction to Design II
- Process simulators
- Engineering economics and profitability analysis
- Teams discussions

### **Textbooks suggested:**

- *Plant Design and Economics for Chemical Engineers*, Peters, Timmerhaus, and West 5<sup>th</sup> Edition, 2003, McGraw-Hill Book Co., NY, NY, ISBN 0-07-239266-5.
  - *User Manual*, ASPEN.
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## **CHEE 4361 – CHEMICAL ENGINEERING PRACTICES**

Minimum Course Content:

- Laboratory Safety, Practices and Precautions
- LabView Software and National Instruments Equipment
- Process Equipment and Instrumentation
- Report Writing
- Technical Presentations
- Teamwork / Working in Groups
- Library Research, Technical resources, Search engines, Handbooks, etc.
- Experimental Techniques

Does not have to be “LabView”, but students must learn to operate and control instrumentation via computer interface, including use of process control set-points and determination of appropriate control parameters (e.g. PID settings). Minimally, all students should participate in experiments involving multi-plate or packed column separations, reaction kinetics, and analysis of fluid flow regimes.

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### **CHEE 4366 – BIOMOLECULAR ENGINEERING**

Minimum Course Content:

- Basics of applied microbiology and biochemistry
- Enzymes and enzyme kinetics
- Bioinformatics, genomics and proteomics
- Recombinant DNA, protein engineering and genetic medicine
- Protein expression, purification and analysis
- Molecular diagnostics
- Ethical and societal issues
- Biopharmaceutical and biotechnological development and commercialization

**Textbook suggested:**

*Molecular Biotechnology* (4<sup>th</sup> Edition) by Bernard L. Glick, Jack J. Pasternak and Cheryl L. Patten (ASM Press, 2010).

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### **CHEE 4367 – CHEMICAL REACTION ENGINEERING**

Minimum Course Content:

- History and Role of Chemical Reaction Engineering in the Solution of Societal Problems & Current Challenges
  - Review of Stoichiometry and Thermodynamics
  - Basic Concepts in Chemical Kinetics
  - Introduction to Heterogeneous Catalysis
  - Ideal Reactor Models
  - Reactor Design for Multiple Reactions, Yield and Selectivity
  - Reactor Design for Non-isothermal Operation
  - Non-ideal flow in Reactors
  - Introduction to the design of catalytic reactors
  - Packed bed reactors
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