10.37 Course Schedule (Spring 2003)

Feb. 5	*Anatomy of a chemical reaction:* Reaction stoichiometry, lumped stoichiometries in bioconversions and cell growth (yields); extent of reaction, independence of reactions, measures of concentration. Single reactions and reaction networks, bioreaction pathways (GS). (Reading Assignment (RA): Notes)
7	*The reaction rate:* Definition in terms of reacting compounds and reaction extent; rate laws, Arrhenius equation, elementary, reversible, non-elementary, catalytic reactions. Rate of cell growth and cell-dependent reactions (GS). (RA: Notes, Sections: 1.1, 3.1)
10	*Recitation.* Problem set 1 due
12	*Reaction mechanisms and rate laws:* Reactive intermediates and steady state approximation in reaction mechanisms. Rate-limiting step. Briggs-Haldane enzymatic kinetics, pyrolysis reactions (GS). (RA: Notes, Sections 7.1, 7.2)
14	*Kinetics of cell-associated processes*. Cell growth kinetics; substrate uptake and product formation in microbial growth, specific rates; mammalian cell growth and intracellular kinetic processes (CLC). (RA: Section 7.5)
17	No class. Presidents Day
19	*Kinetics of enzymatic reactions.* Michaelis-Menten kinetics; enzymatic regulation, enzyme denaturation and deactivation; effect of temperature, pH and other factors on enzyme kinetics; industrial and medical applications of enzymes (GS). (RA: Notes, Section 7.4)
21	*Kinetic treatment of chain reactions.* Pyrolysis, polymerization, long chain approxiamation (GS). (RA: Section 7.3)
24	*Recitation.* Problem set 2 due
26	*The reactor environment.* The batch reactor; isothermal design equations; reactor sizing for constant volume and variable volume processes; batch fermentors for cell growth and pharmaceuticals production. Batch process optimization (GS). (RA: Sections 1.2, 1.3, 1.5, 2.1, 2.2.1, 3.3.1, 3.3.2, 3.3.4, 4.1, 4.2.1)
28	*The reactor environment.* The Plug Flow Reactor (GS). (RA: 1.4.2, 1.4.3, 2.1, 2.2.2, 2.3(PFR), 2.4(PFR), 3.3.3, 3.3.4, 3.4, 3.5, 4.3, 4.4)
March 3	*Recitation.* Problem set 3 due.
5	*The reactor environment.* The perfectly mixed flow reactor, or Continuous Stirred Tank Reactor (CSTR). (GS). (RA: 1.4.1, 2.2.2, 2.3, 2.4, 2.5, 3.3.3, 3.3.4, 4.2.2, 4.6)
7	Reactor size comparisons for PFR and CSTR. Reactors in series and in parallel. Unsteady state operation: start up of CSTR's and semi-continuous or fed batch fermentors (GS). (RA: Sections 2.2, 2.3, 2.4, 2.5; 4.7)
10	*Recitation.* Problem set 4 due.
12	*Biological reactors.* The batch reactor, theory of the chemostat, fed batch or semi-continuous fermentor operation; other bioreactor configurations (GS). (RA: Notes)

?	*Exam 1 (Exact time and date to be determined)*
14	*Data collection and analysis.* Experimental methods for the determination of kinetic parameters of chemical and enzymatic reactions; determination of cell growth parameters; statistical analysis and model discrimination (GS). (RA: Notes, Chapter 5)
17	*Recitation.* Discussion of exam 1
19	*Analysis of rate equations.* Parallel, series (consecutive) reactions, systems of reactions and bioreaction networks; fluxes of metabolic networks; impact of reactor choice on yield and selectivity of products (GS). (RA: Chapter 6)
21	*Non isothermal reactors*. Derivation of energy balances for ideal reactors; equilibrium conversion (CLC). (RA: 8.1, 8.2, 8.4)
24-28	*Spring Vacation*
31	*Recitation.* Problem set 5 due
Apr. 2	*Non isothermal reactors.* Adiabatic and non-adiabatic reactor operation. Enzyme reactors, sterilization in bioprocesses (CLC). (RA: 8.3, 8.5)
4	*Non-isothermal CSTR.* Multiplicity of steady states; stability phenomena, ignition and extinction. Mixed culture bioreactors (CLC). (RA: 8.6)
7	*Recitation.* Problem set 6 due
9	*Catalysis.* Inorganic and enzyme catalysts and their properties; kinetics of heterogeneous catalytic reactions; adsorption isotherms, derivation of rate laws; Langmuir-Hinshelwood kinetics (CLC). (RA: 10.1, 10.2, 10.3)
11	*Catalysis and kinetics of catalytic systems*, catalyst deactivation (continued) (CLC) (RA 10.4, 10.7)
14	*Recitation.* Problem set 7 due.
16	*Mass transfer resistances.* External diffusion effects. Enzyme and immobilized cell reactors (CLC). (RA: 11.1, 11.2, 11.3)
18	Exam 2. In class
21	Patriot's Day - No Class
23	*Reaction and diffusion in porous catalysts*. Effective diffusivity, internal and overall effectiveness factor, Thiele modulus, apparent reaction rates (CLC). (RA: 12.1, 12.2, 12.3, 12.4)
25	*Reaction and diffusion in porous catalysts (continued)* (RA: 12.5, 12.6)
28	*Recitation.* Problem set 8 due
30	*Immobilized enzymes, reactor and operating strategy.* Analysis and applications (CLC)
May 2	*Gas-liquid reactions in multiphase systems* (CLC)

5	*Recitation.* Problem set 9 due
7	*Oxygen transfer in fermentors*. Applications of gas-liquid transport with reaction (GS)
9	*Multiplicity of steady states in microbial reactors.* Mixed microbial systems in continuous flow bioreactors (GS)
12	*Recitation.* Problem set 10 due
14	*Course review* (GS)
15-20	Final Exam Period - Exam 3