SYLLABUS FOR CHROMATOGRAPHIC SEPARATION PROCESSES
Spring Semester, 2011

CLASS: Chromatographic Separation Processes, CHME-4400 and CHME-6967
Meets Monday and Thursday in Ricketts 211 from: 12-1:15 PM

INSTRUCTOR: Steven M. Cramer, William Weightman Walker Professor, Department of Chemical and Biological Engineering, 3211 CBIS, Ext. 6198, crames@rpi.edu, Office Hours, 1-2:30 Wednesday, outside 3211 CBIS.

TEACHING ASSISTANT: Rahul Sheth (shethr2@rpi.edu) 3215 CBIS, ext 4275, Office Hours, 10:45-12:15 Thursday, outside 3211 CBIS.

This is an interdisciplinary course suitable for graduate students and qualified seniors in Chemical Engineering, Chemistry, Biology, and Biomedical Engineering. The objective of this course is to familiarize the student with the theory and practice of the state of the art of analytical and preparative chromatographic separation processes. Topics include: general concepts (e.g. dynamics of zone migration, multicomponent adsorption, chromatographic dispersion, linear and non-linear chromatography); liquid chromatographic techniques (e.g. reversed-phase, ion exchange, affinity, chiral, metal chelate, and size exclusion); modes of operation (e.g. gradient, preparative elution, displacement, and continuous chromatography); novel morphologies (e.g. annular, radial flow, perfusion, and membrane chromatography) and chromatographic applications in biotechnology (applications of various modes of operation sequencing of chromatographic operations, and multidimensional separations for proteomics). Critical reviews of the current literature will be carried out to expose the students to the latest developments in the field. Laboratory demonstrations as well as computer simulations will be employed throughout the course to illustrate important concepts. An individual project on a chromatographic topic of interest will be required for graduate students and will be optional (i.e. extra credit) for undergraduates.

Course Materials: No text is required for this course. A variety of reference books and research papers will be used in the course and extensive handouts will be given on all topics.

Student Work:
Students taking CHME-4400: Weekly homework assignments (20%), Mid-term (35%) and final exam (45%). (note: undergraduate students can obtain extra credit by doing an individual project).

Students taking CHME-6967: Weekly homework assignments (15%), Oral and written presentations on special topic reports (25%), Mid-term (25%) and final exam (35%).

Laboratory Demonstrations: There will be laboratory demonstrations to help illustrate the chromatographic concepts presented in the lectures.

Computer Simulations: Computer simulations will be employed to simulate Displacement Chromatography, Gradient Chromatography and Multi-step Downstream Bioprocessing to gain insight into these state-or-the-art technologies and to instruct the student how to optimize sequential chromatographic separations for the downstream processing of

biopharmaceuticals. In addition, there will be an Aspen chromatography based simulation project to develop a state of the art weak partitioning antibody purification process.

Course Outline: Chromatographic Separations Processes

A. Introduction
B. Chromatographic Fundamentals
1. Retention
2. Band Spreading
3. Resolution

C. Dynamics of Chromatography
1. Basic mass transfer equations
2. Method of moments
3. Linear dispersion model
4. Linear staged models for chromatography

D. Instrument Requirements for Chromatography
1. System design
2. Column packing techniques

E. Fundamentals of Adsorption
1. Gibbs adsorption isotherm
2. Adsorption isotherm models
3. Local equilibrium theory and solute movement plots

F. Modes of Chromatography
1. Reversed phase and hydrophobic interaction
2. Ion exchange
3. Size-exclusion
4. Group specific and biospecific affinity

G. Detectors in Liquid Chromatography
1. UV-Vis
2. Refractive Index
3. Fluorescence
4. Mass Spec.

H. Gradient Elution Chromatography

I. Preparative Chromatography
1. Preparative elution
2 Frontal
3. Gradient
4. Displacement chromatography
5. Optimization

J. Novel Chromatographic Morphologies
1. Continuous annular systems
2. Radial flow
3. Perfusion chromatography
4. Membrane chromatography

K. Chromatographic Applications in Biotechnology
1. Applications of various modes of operation
2. Sequencing of chromatographic operations
3. multidimensional separations for proteomics