10.490 - ICE Module #1
Batch Process Development
Fall 2005
Course Syllabus and Schedule

8th September 2005

Instructors: Professor Paul I. Barton (66-464; x3-6526) pib@mit.edu
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Meeting Hours:
Section I  MTThF  10 AM  66-144
Section II MTThF  11 AM  66-144

The class will have three types of meeting: regular lectures, recitation sessions and office hours. Regular lectures will be held in 66-144 and are indicated on the course schedule by the lecture title and the initials of the instructor. Recitation sessions will also be held in 66-144 by the course instructors. No formal lecture material will be taught in recitation sessions; instead, students will be expected to bring questions and participate in a discussion of their design projects. Office hour sessions will be held in the instructor’s offices. During these periods, the instructor’s offices will be open to any students with questions concerning their design projects.

Office Hours:

TA hours will be announced in class. Consultations during other times can be made by appointment with the instructors and TAs. We all want to make ourselves as accessible as possible to help you, but the responsibility still lies with you to contact us either during regular hours or by appointment.

We will also be offering optional electronic classroom sessions to familiarize you with the software used in this course (ABACUSS II). Sign up sheets will be distributed in class ahead of time.

Grading:

Class participation 10 %
Homework 20 %
Final Report 70 %

Homework assignments should be completed individually while all report assignments should be submitted as group contributions. Each individual homework assignment will be graded on a scale from 0 to 10. Draft sections of the final report will be graded for style and technical content and will count towards the final report grade. The style grade will be based on cogency and effectiveness of communication. Style will be graded as Excellent (E), Satisfactory (S), or Needs Improvement (N). In grading the technical content, we will
evaluate your approach, methodology, understanding, and accuracy. The technical content grade will again range from 0 to 10. The grading of the completed final report will be 1/3 on style and 2/3 on technical content.

It is course policy that students should not refer to either homework or final project solutions from earlier years. If it is discovered that reference has been made to earlier years, the students involved will receive no credit for the assignment in question. Note that we change the underlying models in ABACUSS from year to year, so the results generated by this software change.

**Final Report Requirements**

Each group must prepare a final report that discusses their process design for the production of 300,000 lbs of Lucretex monomer. In order to facilitate meeting this objective without compressing the entire report preparation into the last week of classes, we would like you to submit drafts of several sections as assignments throughout the module. Specific sections are listed under the “List of Assignments” section that follows later in this syllabus. The format for the final report is given below with recommended page lengths for each section shown in parentheses. Please note that we expect you to conform closely to these guidelines; in particular, reports that are too long will be penalized.

1. **Executive Summary (1-2 page(s))**
   - intended for upper management: motivation, goals, approach and results discussed briefly; no details of process included

2. **Table of Contents**
   - and don’t forget page numbers!

3. **Introduction (2 pages)**
   - project background
   - project goals
   - general approach
   - process flowsheet description

4. **Base case process simulation (2-3 pages plus charts and tables)**
   - mass balance calculation results
   - constraints and assumptions listed
   - physical property model and data specifications

5. **Base case economic analysis (2-3 pages plus charts and tables)**
   - batch process design concepts
   - constraints and assumptions listed

6. **Recommended optimum batch process design: configuration and operating conditions (4-6 pages plus charts and tables)**
• process flowsheet, stream tables, process recipe and all equipment sizes, reaction and distillation times for your optimized design case of lowest cost and total processing time (use tables when appropriate)

• rationale behind your design (how did you choose your final design? discuss tradeoffs)

• describe production rate/campaign time and economics results (use charts and tables)

7. Analysis of Risks and Hazards Posed by Operation of Recommended Process (2-3 pages)

• environmental analysis. What are the waste streams generated by your process (magnitude, composition, medium)? What chemical species in these streams are regulated and in what way? What treatment or abatement technologies might be appropriate for each waste stream? What is the eventual fate of the waste material and its impact on the environment? Are there opportunities to improve material recovery and recycling by altering your design (pollution prevention)? What are the costs associated with pollution prevention?

• safety analysis. What are the potential safety hazards associated with operating your design? What events or failures can lead to a release of material from your process? What are the health impacts of these releases for plant workers and the general public (toxicity, flammability, explosion)? What events pose the most significant risks (note that risk is a combination of impact and likelihood)? What measures could be taken to mitigate the most significant risks?

In many cases, what distinguishes a safety hazard from an environmental hazard is the time scale over which the release of material takes place. Safety hazards are caused by the rapid release of material into the environment and its immediate impact on people's health, whereas environmental hazards are caused by the slow release of material into the environment and the health effects of the eventual accumulation of this material in the environment.

8. Appendices (must be well organized!)

• ABACUSS (SIMULATION block only) input files for the base case and final optimized design (two sets only please).

• detailed mass balances for each unit and for the process as a whole

• analyses of size factors, production rate, number of batches, etc.

• detailed process economics.
Course Library:


List of Handouts:

H1. Notes for reaction engineering submodule.
H2. Notes for batch distillation submodule.
H3. Notes for batch process design and production planning submodule.
H4. Notes on batch process design in industry.
H5. Notes concerning plant safety and risk analysis.

List of Memos:

M1. Lucretex Batch Process Design Project Description and Goals
M2. Results of Kinetic Experiments for Reaction I
M3. Analysis of Kinetics Experiments for Reaction I
M4. Kinetic Model for Reaction I
M5. Instructions for using the ABACUSS batch reactor model on Athena
M6. Instructions for using the ABACUSS batch distillation model on Athena
M7. Physical Property Data for all Components in Lucretex Process
M8. Lucretex Project Process Constraints, Available Equipment Inventory, and Cost Figures
M9. Base Case Process Flowsheet Simulation: Operating Conditions and Equipment Assignments
List of Assignments (Homework and Final Report Sections):

A1. Kinetics for reactions I and III
A2. Batch Distillation: Binary and Multicomponent
A3. Base-Case Process Simulation
A4. Base Case Economic Analysis
A5. Complete Final Report

Course Locker:

Most memos and homework assignments will be available on the course Web page and an Athena locker called 10.490. You can gain access to this locker by typing at the Athena prompt:

```
athena> attach 10.490
athena> cd /mit/10.490/Public
```

To print out copies of a file filename.pdf, type:

```
athena> add acro
athena> acroread filename.pdf
```

and then use the print menu option in Adobe Acrobat.

Course Web Page:

The 10.490 Web Page can be accessed via the menu on Athena, or by directing your favorite Web browser to:

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http://web.mit.edu/10.490/www
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pib:September 1, 2005