

126a: Chemical Engineering Laboratory
Fall 2006
Prof. Richard **Flagan** & Dr. Michael Vicic

ChE 126a is the undergraduate Chemical Engineering Laboratory course. Its purpose is fourfold. You will 1) observe phenomena studied in previous **ChE** courses, 2) perform experiments and become familiar with laboratory techniques, including the use of standard experimental tools and error analysis, 3) learn how to **carry** out real-time measurements with computer data acquisition, and 4) design experiments to achieve an objective, analyze the data relative to the objective, draw firm conclusions from that analysis, present those conclusions in a well-written report, and present a brief but clear oral report.

Dr. Mike Vicic is in charge of the laboratory. His office is Room 117 Spalding, Ext. 4613. The teaching assistants are Derek Bartlett and Tae Hyeon Yoo. Feel free to discuss any aspect of your experiments and reports with these people—they are experts and are there to help you! Prof. **Flagan** is particularly eager to help you perfect your scientific reporting skills.

Students will be assigned a laboratory session and work in teams. Sessions for Fall 2006 are Monday and Wednesday 9AM-Noon or Tuesday and Thursday 1-4PM.

Each student will work as part of a team to complete the following experiments:

1. Multiple-input, multiple-output (MIMO) control
2. Chemical sensor array

Although the experiments will be performed in teams, it is expected that each member of the group will share equally in the actual running of the experiments. You will be asked to maintain a detailed laboratory notebook and may be asked at any time to submit that notebook to the TA. You may keep a single notebook for the group. Each individual is responsible for the preparation of his or her own oral and written communications.

You will be given the access code for the laboratory. **DO NOT SHARE THIS CODE WITH ANY OTHER PERSON.** You will be allowed to perform or prepare experiments outside of regular laboratory hours as long as you have two group members present at all times. **ANY PERSON FOUND IN THE LAB WITHOUT ANOTHER GROUP MEMBER WILL BE SUSPENDED FROM THE COURSE.**

Course Grades

- 45% final written reports
- 35% final oral reports
- 10% memoranda
- 10% participation & notebook

Since each student prepares **his/her** own memoranda, written and oral reports, the grades of the members of a team will not necessarily be the same. Students may share data acquired by the team, but nothing else (**e.g.**, graphs, analysis) may be shared. Attendance at oral presentations is **MANDATORY**—you learn from listening to your classmates. Unauthorized absences from class or laboratory will be reflected in the grade.

Final Written Reports

Each student submits a final written for each experiment. Reports are due at the beginning of the oral presentation. You should submit your reports two different ways:

electronically: vicic@cheme.caltech.edu
paper: to Dr. Vicic

We strongly recommend that you follow the guidelines provided for the structure of the written reports and that you start writing well before the due date.

Final Oral Reports

Each student presents an oral report for each experiment. *Unless we can find a time period that all students can attend, these presentations will take place during normal lab hours on the following dates in Room 113 Spalding:*

October 26,2006 (Thursday)
December 4,2006 (Monday)

A laptop (Windows XP SP2 with MS PowerPoint) is provided with a projector for this session. You should put your presentation file on a USB jump drive or on the network. If you use a Mac, you should check your presentation before your session to make sure special symbols and graphics appear correctly.

If you prefer, you may check out a laptop from Dr. Vicic. (Five laptops are available.) Every laptop is identically configured, and each laptop has software (IGOR Pro, etc.) to which you may not otherwise have access.

We strongly recommend that you follow the guidelines provided for the structure of the oral presentations.

Memoranda

Each student submits a memorandum for each experiment. Memoranda should be submitted electronically to Dr. Vicic via e-mail by 5PM on:

October 13,2006 (Friday)
November 17,2006 (Friday)

Treat the memorandum as a mid-project update. You may use the guidelines provided for the structure of a business memorandum.

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During this lab class you should learn how (or improve your ability) to do the following:

- Devise a specific, concrete objective from a vague work statement.
- Perform a literature search.
- Create a plan to meet this objective and breakdown this plan into tasks.
- Design experiments to achieve goals.
- Schedule and assign tasks amongst members in a group.
- Troubleshoot.
- Maintain a lab notebook.
- Analyze data, perform error analysis and draw conclusions.
- Present your work in a conference setting.
- Write journal-quality reports.

Each experiment is specifically designed for you to learn the following:

Chemical Sensor Array		MIMO Control
<ul style="list-style-type: none"> • Sorption thermodynamics and sensor selection • Simple pattern recognition and statistics • Mass diffusion through a thin film (time-permitting) 	Engineering Science Objectives	<ul style="list-style-type: none"> • P, PI, PID control • Tune controllers (gains) • Time-dependent set points (time-permitting)
<ul style="list-style-type: none"> • System validation • Robustness 	Systems Engineering Objectives	<ul style="list-style-type: none"> • Calibration • Robustness
<ul style="list-style-type: none"> • Real-time measurements • Visualize data (#s, graphs) • Write data to file 	Labview	<ul style="list-style-type: none"> • Real-time measurements • Data manipulation • Write data to a file

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Report Guidelines

Written Final Report

- Your report must be typed and should be *no more than 10 double-spaced pages of text*. Use reasonable margins (one inch), font size (12-point) and font. Include page numbers at the bottom of each page. Check your spelling.
- Attach Figures and Tables at the end of your report. Include as many Figures and Tables you feel are critical to tell your story, but don't include too many. Number each Figure and Table so that you can easily refer to each object in the text. Each object should have a caption to guide the reader. Figures and Tables do not count against your 10-page limit of text.
- One *suggested* structure:
 - Abstract
 - Introduction
 - Theory
 - Apparatus and Methods
 - Results
 - Discussion of Results
 - Conclusions
 - References

Oral Final Report

- Use Powerpoint
- Each presentation must be less than 15 minutes in length (this is strictly controlled!) and will be followed by a 5-minute period for questions.
- Bring one hard copy of your oral presentation slides with you.
- One *possible* structure:
 - Introduction; objectives (what, how, why?)
 - Methods
 - Experimental results (data!)
 - Interpretation of data
 - Summary and conclusions

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Report Guidelines

Business Memorandum

- Business memos are intended to be brief communications and rarely exceed two pages in length. Your memorandum should be *no more than a single page*. Use double-line spacing between elements of the memorandum. For the body of the memo, use single-line spacing within a paragraph and double-line spacing between paragraphs. Don't indent paragraphs in the body. Use reasonable page margins (one inch), font size (12-point) and font.
- Memorandums never include a salutation or a closing. Less formal salutations (Mike:) and closings (Thanks,) are used for informal communications like e-mail. More formal salutations (Dear Dr. Vivic:) and closings (Sincerely,) are reserved for formal communications like business letters.
- One *suggested* structure:

MEMORANDUM

Date: [Date]

To: [Name], [Title, if necessary]

From: [Name], [Title, if necessary]

RE: [Subject]

[Body]

- The body is comprised of four unlabeled parts, each with its own paragraph:
 - Purpose (often just a single sentence)
 - Summary (it's included early so managers with short attention spans still read your important findings and know what you did)
 - Background/Discussion** (sometimes more than a paragraph, but brief)
 - Conclusion/Action**