

Proposal to Reconfigure the NMSU CHME Undergraduate Laboratory Sequence

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Background

As currently configured, undergraduate chemical engineering majors take two chemical engineering laboratory courses, one in the spring semester of their junior year (CHE 322L – Instrumentation and Transport Phenomena Laboratory) and one in the fall semester of their senior year (CHE 422L – Unit Operations and Process Control Laboratory). Each course is two credit hours and meets for two, 2-hour and 45-minute periods per week.

Given the typical enrollment in these courses (20 to 30 students per course, at least over the last two academic years), the number of laboratory meetings that should be devoted to each activity (to be called “experiments” from here on), and given the total in-lab time available, five is the maximum number of experiments that can be comfortably done in one semester. As of this writing, 322L is at this level with five experiments, each of which fits the course title and description well:

1. Double-Pipe Heat Exchanger
2. Linear and Radial Heat Conduction
3. Analysis of Centrifugal Pumps, Valve Coefficients, and Piping
4. Vapor/Liquid Equilibrium
5. Thermocouple/Viscosity Study

CHE 422L is a different matter. While, for my first time teaching this course in the fall of 2013, five experiments were available, some combining and rearrangement of these has since occurred that leaves currently four working experiments:

1. Gas Absorption Using a Packed Column
2. Fixed and Fluidized-Bed Columns
3. Armfield Basic Process Control
4. Control of Interacting Tanks

One additional experiment, Distillation, which hasn't been functioning since 2010, is currently undergoing resurrection and is expected to be available by the fall of 2015. This would give five experiments for 422L as well and would seem to leave the course in good shape.

However, there are some issues, and they are what has prompted this proposal.

Number of Experiments

For ABET purposes and others, it is strongly desired to add another unit operations experiment to 422L, that being one dealing with kinetics and reaction engineering. This would raise the number of experiments in 422L to six, which is more than can be comfortably accommodated. It would be possible, of course, to simply drop one of the other experiments. But there is another issue as well.

Mix of Experiments

While the title of 422L, “Unit Operations and Process Control Laboratory”, is certainly appropriate for the type of experiments performed as the course is currently configured, the timing of those experiments that can be classified as process control is not ideal. While the students will have seen in their lecture courses prior to taking 422L the material needed to perform experiments in distillation, gas absorption, and reaction engineering, the first semester of their senior year, when they are taking 422L, is also when they are first introduced to concepts of process control in CHE 412 – Process Dynamics and Control. Thus they might very well be encountering concepts and ideas in the lab that they haven’t yet seen in the lecture course in which they are nominally introduced.

In addition, there is one additional, currently dormant experimental rig available that could be resurrected, and that also falls into the process control category. It is called “Programmable Logic Control” or “Tank Programmable Logic”, and it involves controlling both the temperature and flow of water into and out of a small tank. If this experiment were brought back online, like the proposed reaction engineering experiment, there would be no room for it

Proposed Laboratory Course Rearrangement

One idea to address the scheduling and number of experiments problem is simply to create a separate, “process control lab” course in the second semester of senior year. The three process control experiments would be moved to this course, leaving room for more experiments in 422L. However, there is a desire to not increase the number of credit hours required for graduation, so a second idea is proposed.

The proposal is to split 422L into two 1-hour courses spread over both semesters of senior year, and, at the same time, split 322L into two 1-hour courses spread over both semesters of junior year.

Addressing the senior year first, as noted, creating a new, say, 423L (“Process Control Laboratory”) in the spring of senior year would provide a home at an appropriate place in the curriculum for the three process control experiments (Armfield process control, interacting tanks, programmable logic control). CHE 422L would be left with four experiments (reaction engineering, packed column, distillation, fixed/fluidized bed), but this would be reduced to a more-comfortable three by moving the fixed/fluidized bed experiment to junior year, thus giving

a total of six experiments for that year.

As far as junior year, a revised 322L would have three experiments, while a new 323L would have the other three. A possible/suggested breakdown is as follows:

CHE 322L

1. Linear and Radial Heat Conduction
2. Vapor/Liquid Equilibrium
3. Thermocouple/Viscosity Study

CHE 323L

1. Double-Pipe Heat Exchanger
2. Analysis of Centrifugal Pumps, Valve Coefficients, and Piping
3. Fixed/Fluidized Bed Columns

CHE 422L

1. Gas Absorption Using a Packed Column
2. Distillation
3. Reaction Engineering

CHE 423L

1. Armfield Basic Process Control
2. Control of Interacting Tanks
3. Programmable Logic Control

One question that arises is, if five is the maximum number of experiments that could be accommodated in a single-semester, two-credit hour course, how is it that six experiments can be fit into a two-semester, one-credit-hour-per-course sequence? After all, the total contact time is the same in both cases.

The answer is two-fold. First, giving the students as many different experiences in their undergraduate laboratory work is a desirable goal. The new sequence has 12 experiments versus 10 for the current one. Second, because of inevitable “dead time” due to the number of groups of students created and the amount of time each group spends with each experiment, resulting in not all students being in the lab every class meeting, it is for the most part just as easy to schedule six experiments over two semesters as it is to schedule five experiments over one, even though the total available contact time is the same in both cases. Accomplishing three experiments per

course is not expected to be a problem.

Summary

Because of an increasing number of undergraduate laboratory experiments becoming available in the coming years and a desire to rearrange experiments to more appropriate positions in the curriculum based on the concepts covered by the experiments, there is a desire to reconfigure the laboratory course offerings in the NMSU Department of Chemical and Materials Engineering. A switch from two two-hour courses to four one-hour courses offered over the junior and senior years as described above offers one possibility to meet these challenges.