

## **The Core Graduate Chemical Engineering Program: Does It Exist?**

**David Kauffman**  
**Chemical and Nuclear Engineering Department**  
**University of New Mexico**  
**Albuquerque, New Mexico**

### Abstract

A survey was undertaken to determine the prevalence and content of a “core” of courses in chemical engineering graduate programs in the United States. The survey was sent to 127 schools. Every school of the 83 replying to the survey had either a set of required courses or a “cafeteria” set of core courses required for graduate degrees. Transport phenomena and thermodynamics were required by almost every school, with kinetics/reaction engineering and applied mathematics following close behind.

### Introduction

There is considerable uniformity among U.S. schools in terms of the content of the undergraduate chemical engineering curriculum. This is due to several reasons: the relatively small community of chemical engineering faculty, especially those who have major influence on curriculum design; the many years of strict ABET program requirements, which left little room for variation if a school wanted to assure itself of a trouble-free review; and the practical matter of the growing number of students who transfer from one school to another. It was suspected that this degree of uniformity carried over to graduate programs, but there was little information available to determine whether this were so.

An initial screening of web sites for fifteen chemical engineering departments in the U.S. showed that most, but not all, have a set of core courses required for graduate students earning masters and/or doctoral degrees in chemical engineering. The sets of core courses, however, are not uniform, though they most often include thermodynamics, transport phenomena in some form, applied mathematics and kinetics/reaction engineering. A wider survey was taken to establish to what extent there is consensus among U.S. universities as to the content of a “core” of courses for graduate degrees in chemical engineering.

## Methods

ASEE's 1999 annual survey <sup>1</sup> and AIChE's 1999-2000 faculty directory <sup>2</sup> were used to identify all U.S. schools which awarded six or more graduate degrees in chemical engineering in the 1998-1999 academic year. There were 127 of them. A simple one-page survey was sent to the department chairs at these schools. The survey was designed to determine whether or not the school had a core, a "cafeteria" core (e.g., student must take three of five specific courses), or no required core. It also asked what courses were in the core and how many units each was, whether the school was on a semester or quarter system, and whether the school offered masters degrees with thesis, without thesis, or both. Responses by mail or fax were requested within about two weeks. A copy of the survey instrument is included in the Appendix.

The results were tabulated. "Credits" from schools on the quarter system and schools with unique credit counting systems were converted to semester hours.

## Results

Eighty-four replies were received, of which 83 were usable. This return of 65% should be representative of the entire population.

All 83 schools reported that they have either a required core (67 schools, 81%), a cafeteria core (9 schools, 11%), or a combination of the two (some required courses plus a small additional "cafeteria"; 7 schools, 8%). A few added notes saying that the core is not required by their official catalogs, but it is enforced virtually 100% through advisement.

A summary of the results is given in Tables 1 and 2. Table 1 shows the number of schools requiring each of the four most common core courses either as required or as part of a "cafeteria" plan. Table 2 shows the number of schools requiring two, three, four, five or six or more semester hours in each of these core course areas.

Thermodynamics and transport phenomena tied for being required most often. Thermodynamics is required as core or part of a "cafeteria" core by 82 of the 83 schools. Transport phenomena, in one form or another, are also required as core or part of a "cafeteria" core by 82 of the 83 schools. Though purists may object, courses labeled as fluid mechanics, heat transfer and mass transfer are included in the transport phenomena category. The next most common category is the field of kinetics/reaction engineering, which is required by 79 (95%) of the 83 schools. Applied mathematics courses are required by 65 (78%) of the 83 schools.

<b>Schools with Required Graduate Core Courses</b>						
	<b>Required Core</b>		<b>“Cafeteria” Core</b>		<b>Total Schools</b>	
	<b>Number</b>	<b>Percent</b>	<b>Number</b>	<b>Percent</b>	<b>Number</b>	<b>Percent</b>
Transport Phenomena	71	86 %	11	13 %	82	99 %
Thermodynamics	69	83 %	13	16 %	82	99 %
Kinetics/Reaction Engineering	65	78 %	14	17 %	79	95 %
Applied Mathematics	56	67 %	9	11 %	65	78 %

Table 1. Survey Results: Schools Requiring Core Courses

<b>Number of Semester Hours for Core Courses</b>					
<b>Schools Requiring</b>	<b>Two Sem.Hrs.</b>	<b>Three Sem.Hrs.</b>	<b>Four Sem.Hrs.</b>	<b>Five Sem.Hrs.</b>	<b>Six or More Sem.Hrs.</b>
Transport Phenomena	-	57	5	3	17
Thermodynamics	1	77	3	-	1
Kinetics/Reaction Engineering	2	74	3	-	-
Applied Mathematics	2	57	2	-	4

Table 2. Survey Results: Semester Hours for Core Courses

Other than these four primary subjects, there is very little uniformity in terms of core requirements. Reported classes include:

	Required Core	“Cafeteria” Core
Research methods 1 to 4 sem.hrs.	11 schools	2 schools
Separations 3 sem.hrs.	3 schools	3 schools
Modeling/process analysis 3 sem.hrs.	2 schools	1 school
Process control 3 sem.hrs.	2 schools	
Safety 1 sem.hr.	1 school	

In addition, a number of schools listed a required seminar. Since many schools have such a requirement without associated semester-hour credit, however, the survey does not adequately address this item.

#### Additional findings

Of the 83 schools, 76 (92%) are on a semester system, with only 7 (8%) on a quarter system. A few schools have recently shifted or are in the process of shifting from quarters to semesters. None seemed to be moving in the other direction.

Of the 83 schools, 58 (70%) reported that they offer masters degrees both with thesis and without thesis. Several, however, indicated that the non-thesis option is very rarely, if ever, used. Twenty-four schools (29%) reported they offer masters degrees only on a thesis basis. One school reported that it exclusively offers masters degrees without a thesis.

#### Conclusions

There is a high degree of uniformity in core requirements for graduate degrees in chemical engineering in the U.S. Results from the survey show that virtually all schools have core requirements, either a single specific slate of courses or a “cafeteria” slate of courses. Transport phenomena and thermodynamics are included in the core of 99% of the schools, with kinetics/reaction engineering close behind at 95%. Applied mathematics is the next most frequently required core course, being included in 78% of the cores. Beyond these four topics, there is little uniformity.

Bibliography:

1. *Profiles of Engineering & Engineering Technology Colleges, 1999 Edition*, American Society for Engineering Education, 2000.
2. D.R. Lloyd, M. Meredith and J.S. Swinnea, eds., *Chemical Engineering Faculty Director, 1999-2000*, Vol. 48, American Institute of Chemical Engineers, 1999.

Biographical Information:

DAVID KAUFFMAN has been on the faculty at the University of New Mexico for 25 years. For fifteen of those years he also served as Associate Dean of the School of Engineering. Prior to joining academia, he worked for Shell Oil Company and served in the U.S. Air Force. His B.S. and M.S. degrees are from the California Institute of Technology; his Ph.D. is from the University of Colorado.

Appendix: Copy of the survey instrument

---

**Chemical Engineering Graduate “Core” Survey**

**University of XXXX**

Are you on a semester or quarter system?

\_\_\_\_\_Semester \_\_\_\_\_Quarter

Do you have a specific set of required “core” courses for graduate degrees in chemical engineering?

\_\_\_\_\_Yes \_\_\_\_\_No

Do you have a “cafeteria core” for graduate degrees in chemical engineering; e.g., student must take three of five specific courses.”

\_\_\_\_\_Yes \_\_\_\_\_No

If yes, please provide the following information for each “core” course:

Subject	Part of Specific Core, Yes or No	Part of Cafeteria Core, Yes or No	Number of Units *
Thermodynamics _____	_____	_____	_____
Kinetics/Reaction Engineering _____	_____	_____	_____
Transport Phenomena _____	_____	_____	_____
Applied Mathematics _____	_____	_____	_____
Research Methods _____	_____	_____	_____
Other _____	_____	_____	_____
Other _____	_____	_____	_____
Other _____	_____	_____	_____
Other _____	_____	_____	_____

Do you offer masters degrees with thesis (\_\_\_\_\_), without thesis (\_\_\_\_\_), or both (\_\_\_\_\_).

Please mail or fax this form by December 15 to:

David Kauffman  
School of Engineering  
University of New Mexico  
Albuquerque, NM 87131-1336

fax: 505-277-1422