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How to get Engineers to take Mathematics Courses

Abstract

One of the challenges to any mathematics department is how to recruit non-majors to take upper level mathematics courses. While several engineering curricula require some upper level mathematics courses, most engineering students only take the bare minimum to meet graduation requirements.

In this paper the author will discuss some three simple methods which have been employed to encouraged students to take upper level mathematics courses. These methods include creating courses of interest to the student, advertising the courses, and encouraging students with A.P. credit to take more mathematics courses. Both individual and department wide examples will be discussed. The results have been very encouraging and in some courses the enrollment has more than doubled and extra sections of the course have had to be added.

Introduction

One of the challenges to any mathematics department is how to recruit non-majors to take upper level mathematics courses. At Rose-Hulman we have incorporated three methods that seem to have promising results. These include creating courses or tracts which interest engineering majors; advertising courses that are being offered, and specifically encouraging students who enter school with advanced placement credits in mathematics to take additional mathematics courses beyond the courses required for their major.

Creating courses and tracts of interest

Over the past few years the Rose-Hulman Mathematics Department has made several changes to encourage students to take upper level mathematics courses. One of the major changes was to change the courses required to get a degree in mathematics. Until the late 1900's Rose had only one tract for a degree or major in mathematics. We have now split this into four different tracts. Our first tract is for the traditional mathematics major who wants to go to graduate school and earn and masters degree or doctorate in mathematics. This tract is not a tract that would interest most engineering students.

Our second tract is a discrete applied mathematics tract which requires students to take our discrete and combinatorial algebra courses. This tract was specifically designed to encourage computer science, computer engineering, electrical engineering, and software engineering students to consider a second major in mathematics or at least a minor in mathematics with a concentration in our discrete applied courses. The computer science/mathematics double major has traditionally been the Mathematics Department's most popular program. By adding this separate mathematics tract we have only enhanced and already popular program.

Our third tract is a probability and statistics/operations research tract. This tract was set up for mathematics majors who would like to go into the actuarial and/or operation research fields. It also allows engineering students who would like some higher level statistics courses or and course in operations research to receive a minor in mathematics by taking course that are more relevant to their fields. This tract is geared towards the applied biology, biomedical engineering, mechanical engineering, and civil engineering majors, and students who are thinking of a concentration in engineering management.

Our fourth tract is the applied continuous mathematics concentration. This concentration is designed for students who like enter graduate school in the areas of differential equations and continuous applied mathematics, or who would like to enter industry with a continuous applied mathematics background. This tract has set up to encourage mechanical, electrical, and chemical engineers, and physics majors to take mathematics courses which are more closely related to their primary disciplines.

Two courses that have had particular success are Boundary Value Problems and Applied Linear Algebra for Engineers. For years, it has been the policy of the Mathematics Department not to allow electrical engineering students to take linear algebra in the last term of their senior year. The reason was simple. By the time the electrical engineering students were seniors they already knew a lot of linear algebra and thus spent little time on their linear algebra course. After several years when seniors failed the linear algebra course and did not graduated on time, the policy was invoked.

Thus, for several years, senior electrical engineers did not take linear algebra. In the late 1900's the Mathematics Department started a new linear algebra class which dealt more with the applications of linear algebra and with theory of linear algebra. By looking at applications such as coding, Markov chains, fast Fourier transforms, image processing, CAT scans, computer graphics and others, the engineers saw useful applications of linear algebra and thus interest in the course grew.

Advertising

It never hurts to advertise your courses. Each term, just before the registration period, the Mathematics Department sends a e-mail to students advertising a webpage where student can find the upper division mathematics course offered the next term. On this web page the students are directed to faculty web pages that explain the courses that are being offered. Some of these web pages have computer graphics, etc. which help explain the course. This has helped increase the number of students in the upper division mathematics courses.

However, fancy advertisements are not always necessary. In the spring of 2003, the author sent a simple e-mail message to all students stating that the Boundary Value Course was being offered. The e-mail stated that the course would show how strings vibrate, how heat dissipates. The email went on to say that for mechanical engineers, chemical engineers, and electrical engineers which would be a good course to take before they took heat transfer, thermodynamics, and courses involving the potential equation. This simple e-mail helped increase the enrollment in the class from six students in 2002 to twenty-two students in 2003.

Advance placement students

Rose-Hulman, like many colleges, has students who enter with advanced placement credits in mathematics. Unlike many schools, Rose-Hulman offers a summer class called Fast Track Calculus, for entering freshman who have completed a year of high school calculus, and have a score of 700 or more on the mathematics portion of the S.A.T. exam. This course is taught each summer during the five week before the beginning of the fall term. During this intensive five week course, the students earn credit for our Calculus I, Calculus II, and Calculus III courses. Thus, when the students enter Rose-Hulman they ready to take our differential equations sequence. This means that during their sophomore year when they should be taking three mathematics courses they have three open slots in their schedule. The Mathematics Department strongly urges these students to take three additional mathematics courses during sophomore year. This virtually completes a minor in mathematics and adds students to our upper division classes.

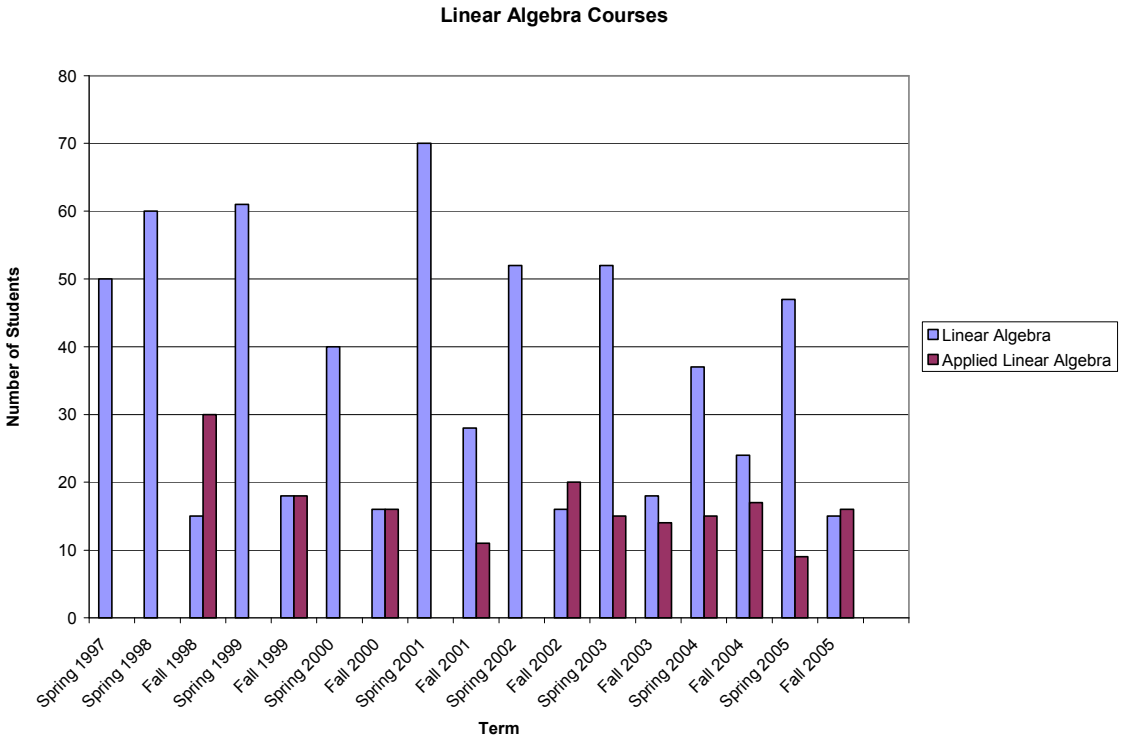
In addition we place our other advanced placement students into the appropriate mathematics course. We have created special sections of calculus and differential equations just for these students. Thus, students with AB credit in calculus are immediately placed into Calculus II, while students with BC credit in calculus are placed into Calculus III. These students are thus able to take an additional mathematics course during their sophomore (or later) year.

Results and charts

When we consider our linear algebra courses we started by adding the applied linear algebra course during the fall term. As the table below and the bar chart show, we started offering the applied linear algebra in the fall of 1998 as an experimental course. At the same time we started offering our regular linear algebra course in the fall. As you can see, the applied linear algebra course had twice as many students as the regular linear algebra course in the fall of 1998.

Beginning in the 2002-2003 school year, we began offering the applied linear algebra course during the spring term. This just about doubled the total enrollment in the applied linear algebra course. The data shows that the number of students in the both linear algebra courses has remained fairly steady each term. Thus by adding the applied linear algebra course we have increased the total enrollment in our linear algebra courses by about 30 students per year.

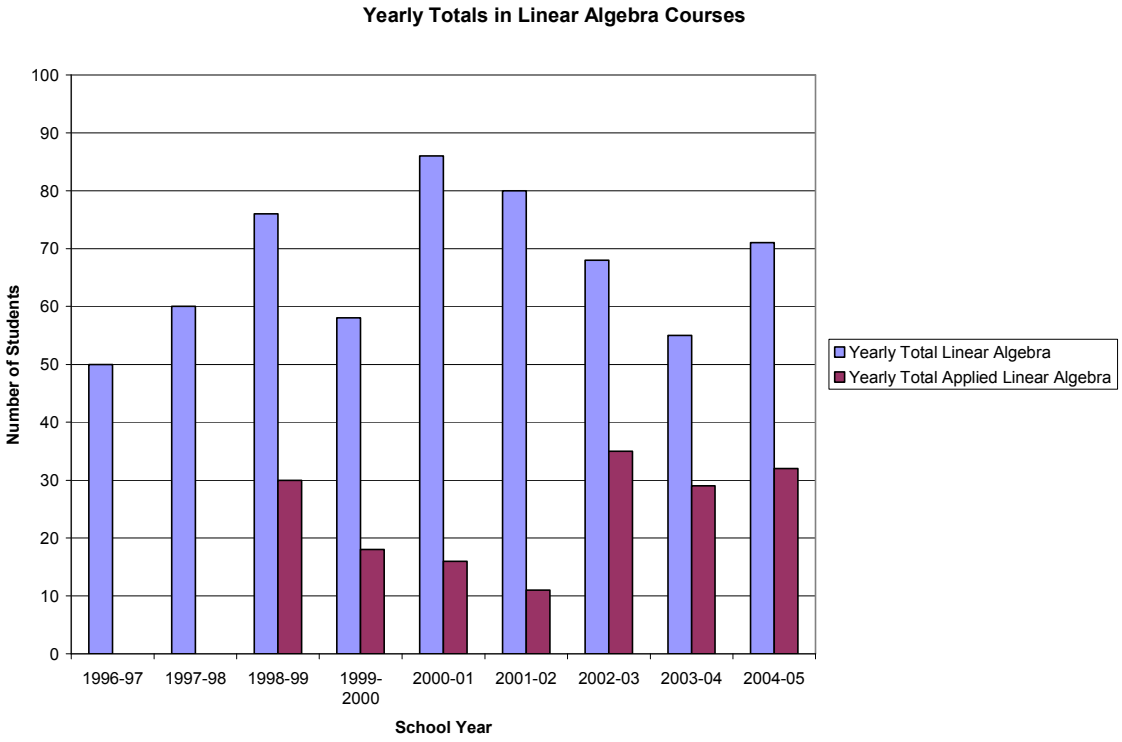
ENROLLMENT IN LINEAR ALGEBRA COURSES BY TERM																	
Term	S 97	S 98	F 98	S 99	F 99	S 00	F 00	S 01	F 01	S 02	F 02	S 03	F 03	S 04	F 04	S 05	F 05
Linear Algebra	50	60	15	61	18	40	16	70	28	52	16	52	18	37	24	47	15
Applied Linear Algebra	0	0	30	0	18	0	16	0	11	0	20	15	14	15	17	9	16



If fact, we have actually increased our total linear algebra enrollment by over 30 students per year. As the following table and chart show, our yearly enrollment in the regular linear algebra course has increased since 1998. Thus, the applied linear algebra course has not adversely affected the enrollment in the regular linear algebra course. The fact that we are now offering our regular linear algebra course in the fall also seems to have helped our over all linear algebra enrollment.

It should be noted that some of the enrollment increase may be due to the increase in size of our student body. With an increased student population it is not unreasonable to expect an increase in the number of students taking linear algebra courses.

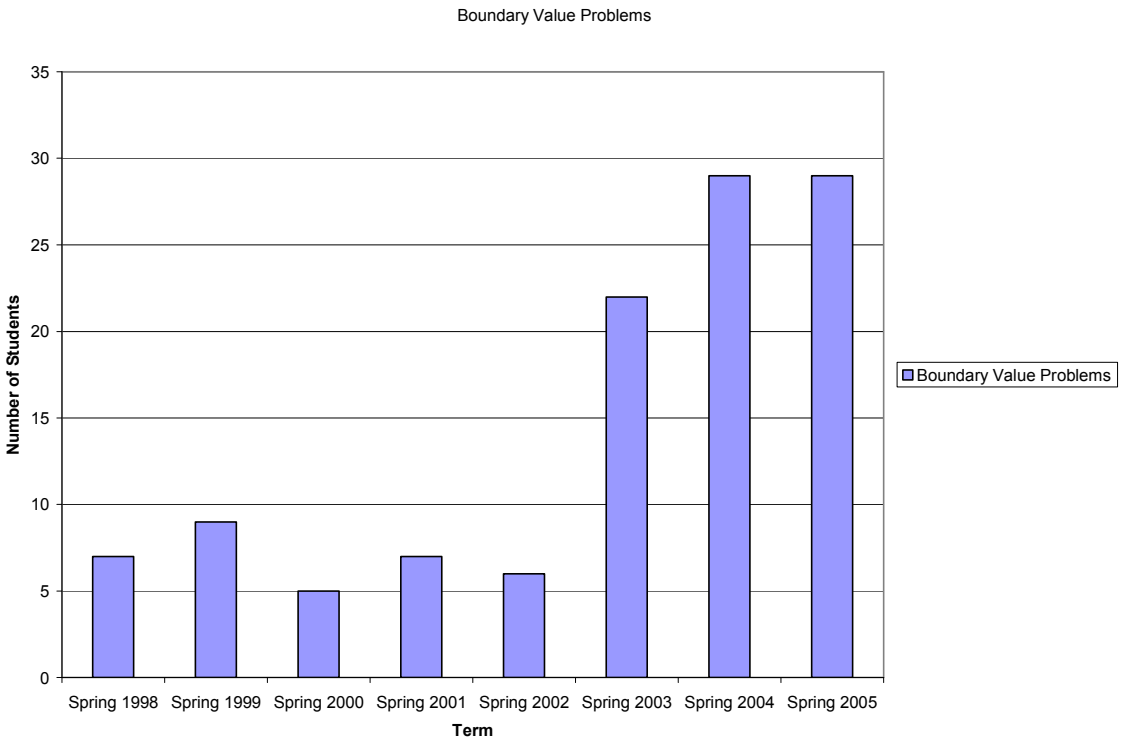
ENROLLMENT IN LINEAR ALGEBRA COURSES BY YEAR									
School Year	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05
Linear Algebra	50	60	76	58	86	80	68	55	71
Applied Linear Algebra	0	0	30	18	16	11	35	29	32



When we consider the case of our boundary value course there is a different scenario. In this case we did not add a new course. Instead, in 2003 we revised the course to make it more attractive to engineers and began to advertise the course as one that the students might find useful. We also encouraged freshman and sophomore students with AP mathematics credit to take this course. The following chart and graph show that the results have been dramatic.

The enrollment immediately almost tripled. Of the twenty-two students in the course in 2003, ten were students with AP credit in mathematics. In 2004 we had twelve students with AP mathematics credit in the course, and in 2005 we had seven students with AP credit in the course. The course has become so popular that we are now adding a second section of the course to keep class size down.

ENROLLMENT IN BOUNDARY VALUE COURSE BY YEAR								
School Year	1998	1999	2000	2001	2002	2003	2004	2005
Enrollment	7	9	5	7	6	22	29	29



Conclusion

A mathematics department can significantly increase the enrollment in upper division courses by instituting three fairly easy techniques:

1) The department can take traditional mathematics courses and retool them so that they are more applied and thus more in tune with the needs and likes of the engineering student. This may be as simple as using engineering applications in the courses.

2) The department can actually advertise their courses to students. This can be done with web pages or even simple mass e-mails. This lets engineering students know that there are, in fact, mathematics courses being offered that will be of benefit to them in their engineering courses or later when they pursue advanced degrees.

3) The department can encourage students to take advanced placement mathematics courses, or offer such courses in a summer program. This allows students to have opens spots in their schedules which the students can use to enroll in upper division mathematics courses.

By using the above techniques a mathematics department can increase the number of students who take upper division mathematics courses, and may well increase the number of students who minor or even get a second major in mathematics.

As we all know mathematics is the basis for all engineering courses. Thus, by encouraging students to take more mathematics courses we are helping to create better engineers.