Engineering Program Revitalization Report

October 29, 2023

Introduction

At the request of the College of Marin Academic Senate, this report has been prepared in accordance with policies BP 4021 and AP 4022 in order to:

- Identify the Engineering Program's weaknesses and challenges;
- Review relevant data;
- Include a list of measurable actions for revitalization;
- Make specific recommendations for improvement.

It is worth noting that although revitalization does provide a useful opportunity for institutional self reflection, it was probably not the appropriate process for this circumstance. As noted in BP 4021 and AP 4022, revitalization is a *process for discontinuing instructional programs,* [etc.] *identified as no longer meeting the requirements of four-year institutions or serving any need …* Furthermore, the *criteria for identifying at-risk programs in need of revitalization include*

- *long-term trends over several years of enrollment history;*
- *projections for continued declining enrollment;*
- *success and retention rates over several years;*
- *changes in the academic discipline in terms of articulation changes established by transfer colleges and universities that affect the viability of program offerings; and*
- *other factors demonstrating that the program is in decline and predict it will continue to decline.*

As detailed in the following report, **none of these criteria actually apply to COM's Engineering Program**. It is clear that the program meets the requirements of four-year institutions and serves an important need for our students and for our society. Furthermore, aside from some minor fluctuations, the program's enrollments, success and retention rates, articulation and transfers, etc., have remained fairly stable over the past two decades (despite the 40% decline in the college's overall enrollment during that time period). Although most ENGG courses have enrollments in the single digits or low teens, this has been the case for decades and is likely to continue into the future.

In fact, this revitalization report relies heavily upon a detailed Engineering Program Review that was prepared in March 2008 during the effort to rescue the college's accreditation after being placed on probation by ACCJC. Nearly all of the information in the 2008 report remains relevant today, including explanations for why the ENGG course enrollments are what one would expect for a college of COM's size, and why these enrollments do not perfectly reflect the number of COM students pursuing transfer in Engineering and Computer Science (or in other words, why the ENGG discipline is not synonymous with the Engineering Program). The explanations are updated and included on the following pages.

Also included on the following pages is an explanation of equity considerations for maintaining ENGG course offerings, as well as a summary of some recent developments at COM that may improve the trajectory of ENGG enrollments, including the establishment of a MESA program (which was ironically the last recommendation on the last page of the 2008 report). This report also concludes with a list of recommendations, including that the institution should use this revitalization process as an opportunity to reflect upon its commitment regarding ENGG course offerings and to provide clear future direction for faculty and students.

Program Definition

- College of Marin's Engineering program predominantly serves students who intend to transfer to a university to complete a Bachelor's degree, but occasionally includes students with other objectives (e.g., professional development). As with most CC Engineering programs, few students obtain an A.S. degree, since it often requires some additional coursework beyond what is needed for transfer (which is already onerous), and since it is of little value professionally.

- Since there are literally dozens of distinct undergraduate Engineering Majors across the CSU and UC systems, 'Engineering' is really a broad umbrella term analogous to 'Liberal Arts', rather than a specific designation of program or major. Note that at most UC campuses, there is a *College of* or *School of* Engineering that usually includes about 15% to 20% of all undergraduate students.

- It is important to note that courses within College of Marin's **Engineering (ENGG) Discipline represent a small fraction of the Engineering Program**. In fact, a significant number of engineering students are able to successfully transfer without taking any ENGG courses, and most transfer after having only taken one or two ENGG courses. From the perspective of students and universities, **the Engineering Program is composed primarily of Math, Physics, and Chemistry courses**.

- Table 1 on the next page shows the lower-division courses that are typically required for transfer into about 10 common UC and CSU engineering majors. The actual requirements vary substantially depending not only on the major (e.g., Civil, Electrical, etc.), but also on the specific CSU or UC campus, as well as on other factors such as the student's GPA. For each major, courses that are required for nearly all students are indicated with an **X**, while courses that are required for only some students are indicated with a **?**. Note that the courses required for nearly all engineering students include 5 math courses, 3 physics courses, and 2 chemistry courses. Because of variations among majors, UC/CSU campuses, and student circumstances, **none of the ENGG or COMP courses are taken by a majority of engineering transfers**.

- As a result, the number of Engineering and Computer Science majors at College of Marin is much larger that one might expect based on enrollments in ENGG and COMP courses. Figure 1 and Figure 2 display results from a recent (late October) survey of students in the Table 1 courses that were offered this semester. Figure 1 reveals that the students in ENGG courses are the 'tip of the iceberg' among the total 146 self-declared Engineering or CS majors surveyed. Figure 2 shows the relative proportions of these students compared to non-Engineering/CS majors in the same courses. It is clear from these survey results that a major portion of students in our STEM courses consider themselves Engineering/CS majors, even if they never intend to take an ENGG course.

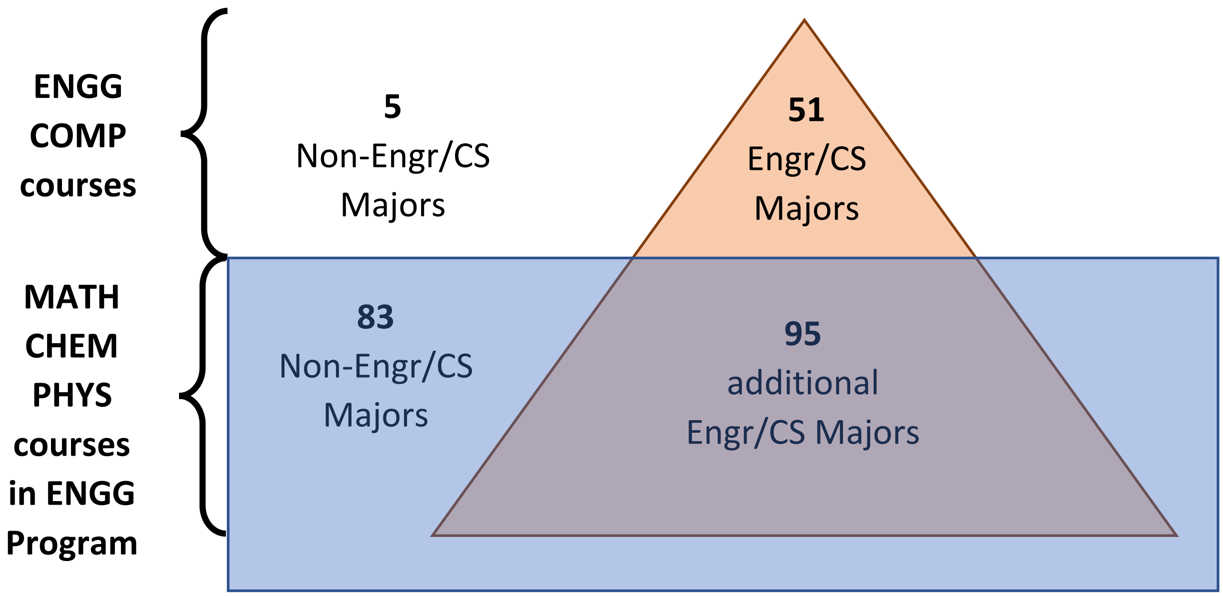
- The students who are most likely to transfer without any ENGG courses are those that have high GPAs, transfer to elite programs (e.g., UCB and UCLA), and can afford to spend a third year at the university completing their degree. Conversely, **the students most in need of our ENGG courses are those who are less advantaged** in terms of academic preparation and financial circumstances.

Table 1. COM Engineering Program from the Transfer Perspective.

X indicates course is required for nearly all students. ? indicates course is required for some students.

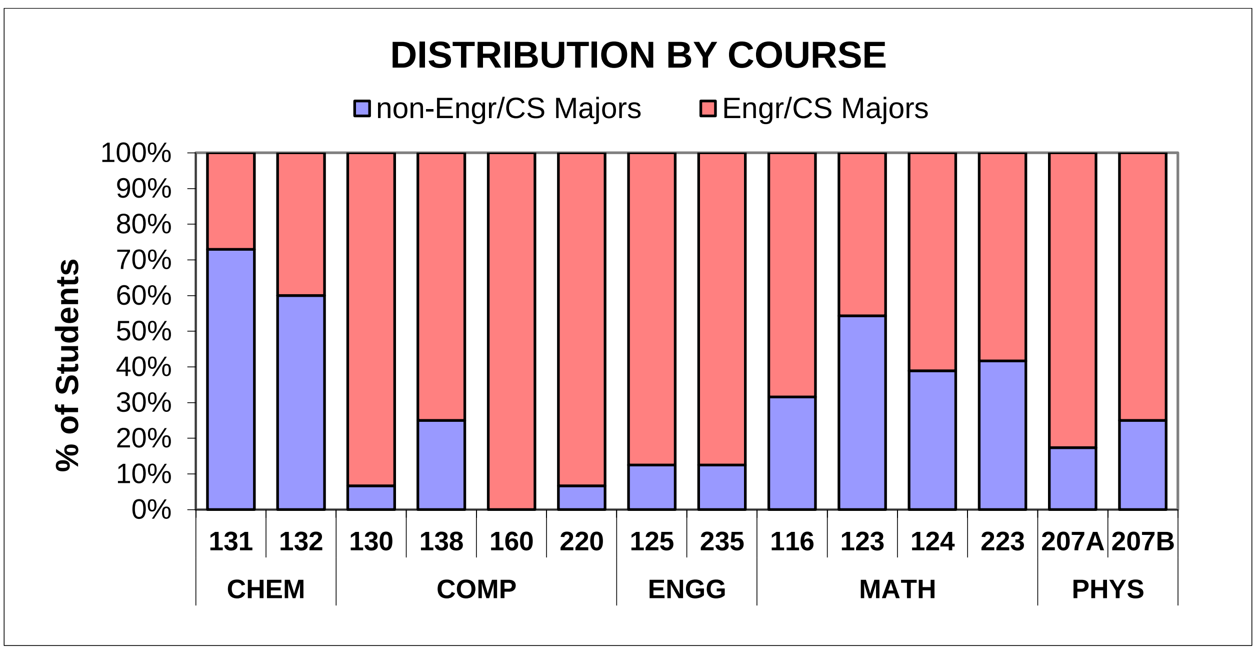
		Engineering Major									
Course ID	**Course name**	**Aero**	**Bio**	**Chem**	**Civil**	**Comp E**	**C Sci**	**Elec**	**Indus**	**Matls**	**Mech**
MATH 123	Calculus I	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
MATH 124	Calculus II	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
MATH 223	Multivariable Calculus	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
MATH 224	Differential Equations	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
MATH 116	Linear Algebra	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
PHYS 207A	Mechanics	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
PHYS 207B	Electricity & Magnetism	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
PHYS 207C	Heat, Light, Modern	**X**	**?**	**?**	**?**	**X**	**?**	**X**	**?**	**X**	**X**
CHEM 131	General Chem I	**X**	**X**	**X**	**X**	**?**	**?**	**?**	**X**	**X**	**X**
CHEM 132	General Chem II	**X**	**X**	**X**	**X**	**?**	**?**	**?**	**?**	**X**	**X**
CHEM 231	Organic Chem I		**X**	**X**							
CHEM 232	Organic Chem II		**X**	**X**							
ENGG 110	**Intro**										
ENGG 125	**Graphics**	**?**			**?**				**?**		**?**
ENGG 150	**Progr in MATLAB**	**?**	**?**	**?**	**?**			**?**	**?**	**?**	**?**
ENGG 220/220L	**Circuits**	**?**	**?**			**?**	**?**	**X**	**?**		**?**
ENGG 235	**Statics**	**?**			**?**				**?**	**?**	**?**
ENGG 245	**Materials**	**?**		**?**	**?**				**?**	**?**	**?**
COMP 117	Discrete Math					**X**	**X**				
COMP 130 or 135 or 138	Intro Progr in C++ or Java or Python	**?**	**?**	**?**	**?**	**X**	**X**	**X**	**?**	**?**	**?**
COMP 160	Computer Orgnzn					**X**	**X**	**X**			
COMP 220	Data Structures					**X**	**X**				
COMP 235 / 232	Adv Progr C++ / Java					**?**	**?**	**?**			

Figure 1. Unduplicated number of Engineering & Computer Science majors in pathway courses based on survey responses in October, 2023



Note: Values represent unduplicated counts among survey respondents from courses listed in Table 1 at approximately midterm in Fall 2023. Respondents represent only a fraction of census enrollments in these courses. Based on more detailed surveys of the Engr/CS majors within CHEM, COMP, ENGG, and PHYS classes, approximately 55% self-identify as CS majors and 45% as other types of Engineering majors.

Figure 2. Distribution of Engineering & CS majors within select courses based on survey responses in October, 2023



ENGG Curriculum

- For the past decade, the department has tried to consistently offer **one section per year of essentially six ENGG courses** that are common transfer requirements. (Technically, 220 and 220L are listed as separate lecture and lab courses, which makes a total of 7 ENGG courses.)

- As displayed in Table 2 below, **all of these courses are aligned with a statewide C-ID** course descriptor, and as a result are articulated with equivalent courses in the vast majority of UC and CSU engineering programs.

- **All of these courses appear in the statewide Engineering ISMCs** (Intersegmental Model Curricula), which are analogous to the TMCs used as templates for AS-T degrees in other disciplines. Unfortunately, since Engineering was specifically exempted from the SB-1440 legislation, these degrees do not confer any benefits to students who obtain them. However, the inclusion of these specific courses in the ISMCs reflects the statewide consensus that they represent the most common lower-division requirements for the vast majority of UC and CSU engineering majors.

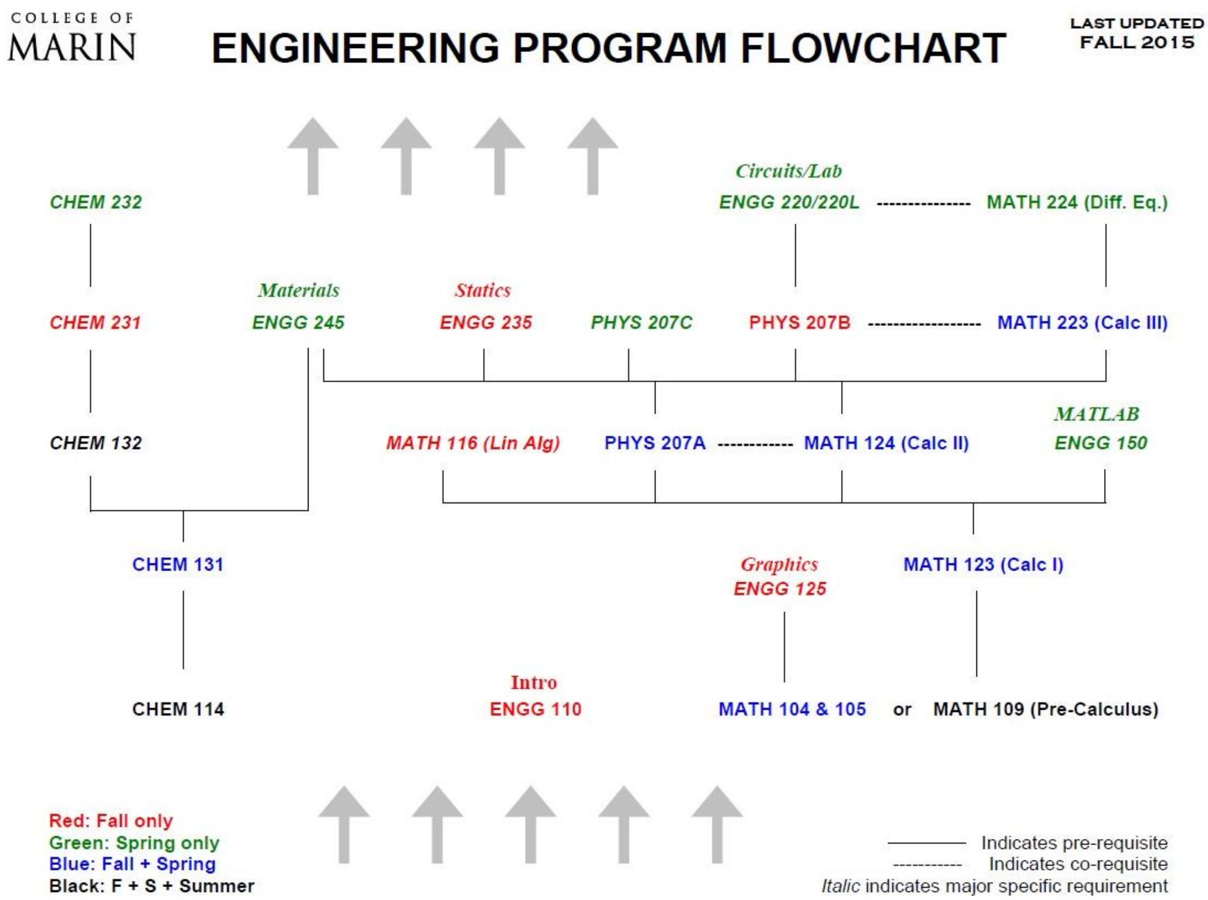
- One of these courses, **ENGG 110 Introduction to Engineering**, is not actually enforced as a requirement for transfer admission by most UC and CSU engineering programs. However, the course **serves as an important guidance tool** for COM students by informing them about various career opportunities within engineering, by exploring academic requirements, and by developing some fundamental skillsets and mindsets that will help them to persevere through the journey.

- Simply getting students to initiate their own academic planning is a major objective of the course. Compared to other transfer majors, Engineering requirements are very specific, have numerous prerequisites and sequences, vary among majors and four-year institutions, and have severe scheduling constraints at a small college that can only offer one section per year. As a result, **students must plan several semesters ahead** in order to complete their requirements in a timely manner. The Engineering Program Flowchart on the following page is an example of a tool useful to students and counselors as they engage in this complex exercise.

Table 2. COM Engineering Course Offerings

course	***CID course***	Course Title	TU	SU	prereqs	Typical Enroll
110	*ENGR 110*	Intro to Engineering	4.5	3	(M103)	6-12
125	*ENGR 150*	Intro Engr Graphics	5.5	4	M104/109	6-12
150	*ENGR 220*	Programming MATLAB	5.5	4	M123	12-18
220	*ENGR 260*	Electric Circuit Analysis	3.0	3	P207B, M224 co	5-10
220L	*ENGR 260L*	Electric Circuit Lab	2.5	1	E220 co	4-8
235	*ENGR 130*	Engr Mechanics: Statics	3.0	3	P207A, M124 co	5-10
245	*ENGR 140B*	Engr Materials Science	5.5	4	P207A, C131	4-8

Figure 3. Flowchart of Engineering transfer curriculum showing pre-requisites and semesters in which courses are available.



ENGG Enrollment and Success

- As shown in Figure 4 below, although the enrollments in ENGG courses have fluctuated slightly over the past 14 years, they have always been in the single digits or low teens, and **recent enrollments are no lower than they were in the past**. In that same time period, College of Marin's overall enrollment has declined by 40%, from an annual credit FTES of 4,923 in 2010-2011 to 2,977 in 2022-2023. When normalizing by the overall college FTES, recent ENGG enrollments may in fact be above average for the past two decades.

- As noted in the 2008 Program Review, when examining enrollments across the CCC system, there is not surprisingly a strong correlation between ENGG course enrollments and the overall size of a college. **When normalized by college size, the ENGG enrollments at COM were around the median** for CCCs at that time, and are possibly above average now, given the shrinking FTES of COM. For example, note that SRJC, which has one of the healthiest and most well respected CC engineering programs in the state, offered two sections of the Materials Science (245) course in the past year, with enrollments of 16 in Spring 2023 and 9 in the current semester. With an annual credit FTES of

11,307, SRJC is 3.8 times the overall size of COM. Normalizing by FTES, we might expect (16+9)/3.8 = 6.6 students per year in our own Materials Science course, in line with our typical enrollment.

- Focusing on the fluctuations in enrollment, from 2010 to 2015 there was a national trend of increasing undergraduate engineering enrollment following the 'Great Recession', which was reflected in our own local ENGG enrollments, appearing first in the 100-level courses and then in the 200-level courses. This growth seemed to subside from 2015 to 2020, at which point COVID caused major disruptions to our course scheduling and enrollments. In the past few semesters, ENGG enrollments seem to be building again, and if the current Fall 2023 enrollments in ENGG 125 and 235 (as well as PHYS 207A and 207B) are any indication, **we can expect this year's enrollments to be the highest in the past 5 years**.

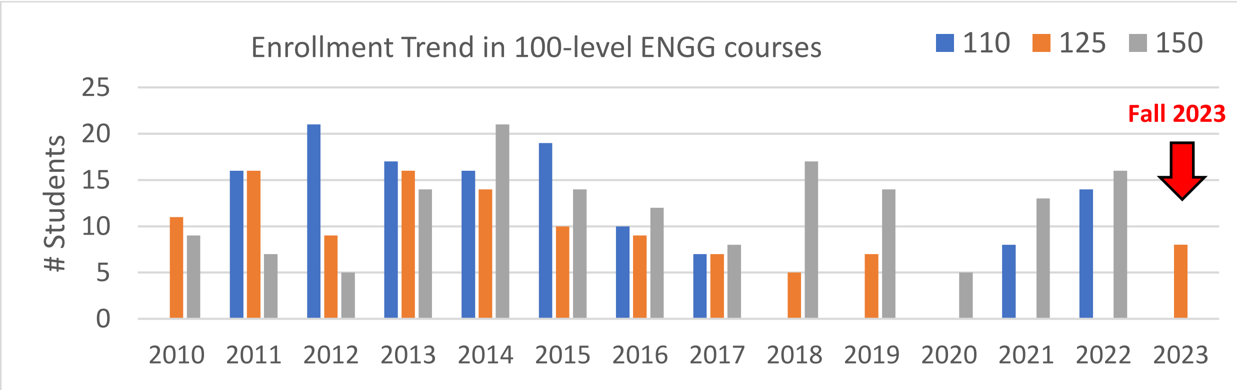
- Gaps in the enrollment history graphs reflect semesters in which a course was either cancelled due to low enrollment (and/or emergency remote status in 2020-2021) or not offered in subsequent years following cancellation. Note that Intro (110) was revised from a 1-unit seminar style course to a 3-unit lecture/lab course in order to better align with the statewide C-ID and trends at other institutions. It was then 'reintroduced' in 2021 using a hybrid approach, and in Spring 2023 as a fully in-person class, and we hope that enrollment continues to build as we offer it again next semester. Similarly, the Graphics (125) course was reintroduced this semester with a new part-time instructor, and there is reason to hope that enthusiasm for the course will build in future years.

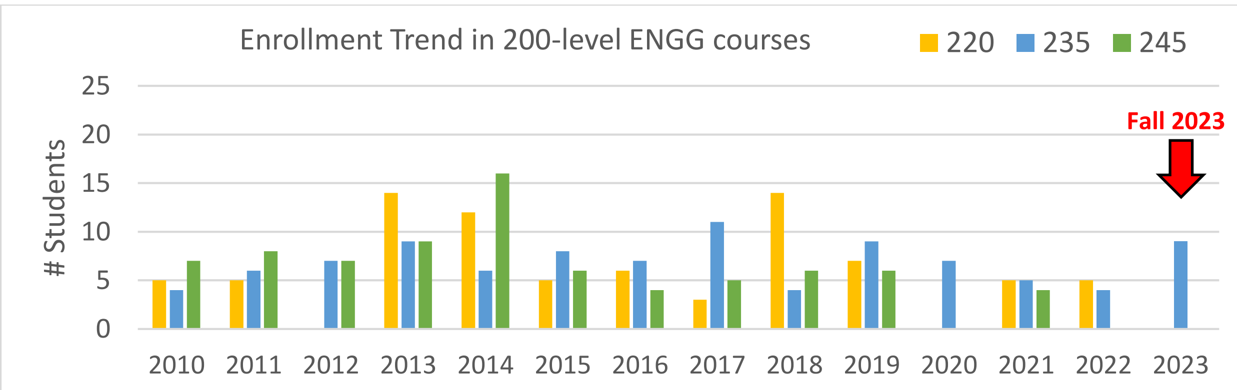
- As shown in Figure 5 below, **retention and success rates in ENGG courses have been consistently high** for the past decade, averaging 93% and 88%, respectively. These outcomes are well above average for the department, for the college, and for the state. Because of the highly sequential nature of the Engineering transfer curriculum, upper level ENGG courses build heavily upon knowledge and skills developed in earlier Math, Chemistry, and Physics courses. The high success rates in ENGG courses are evidence that these pre-requisite courses have been thorough in providing students with the preparation needed for success in engineering coursework.

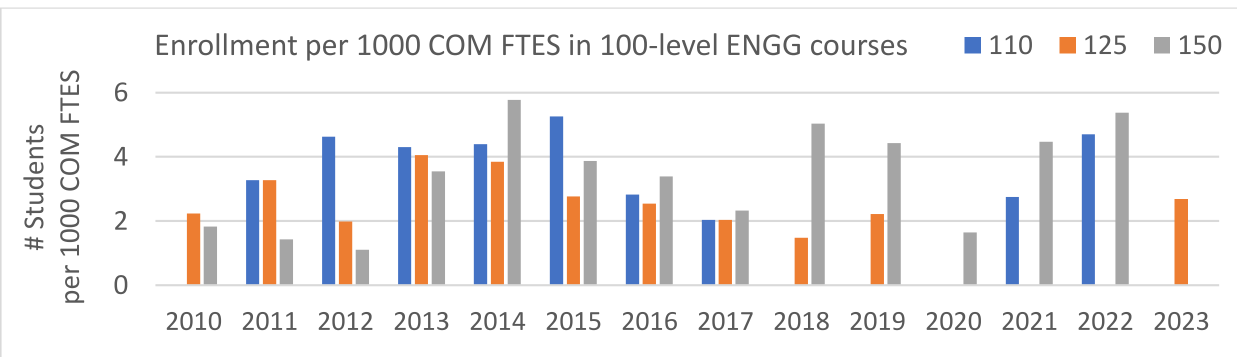
- Although rigorous standards in pre-requisite courses have led to relatively high success rates in ENGG courses, they are unfortunately one of the contributors to low enrollments. For example, even with optimistic success rates of 70% for MATH 109, MATH 123, and PHYS 207A, only 70% x 70% x 70% = 34% of prospective engineering students would make it to any of the 200-level ENGG courses. To enroll in the Electric Circuits (220/220L) course, students need to complete MATH 109, 123, 124, 223 and PHYS 207A, 207B. Clearly, even **marginal gains in success rates among these pre-requisite courses can lead to substantial enrollment increases in the upper level ENGG courses**.

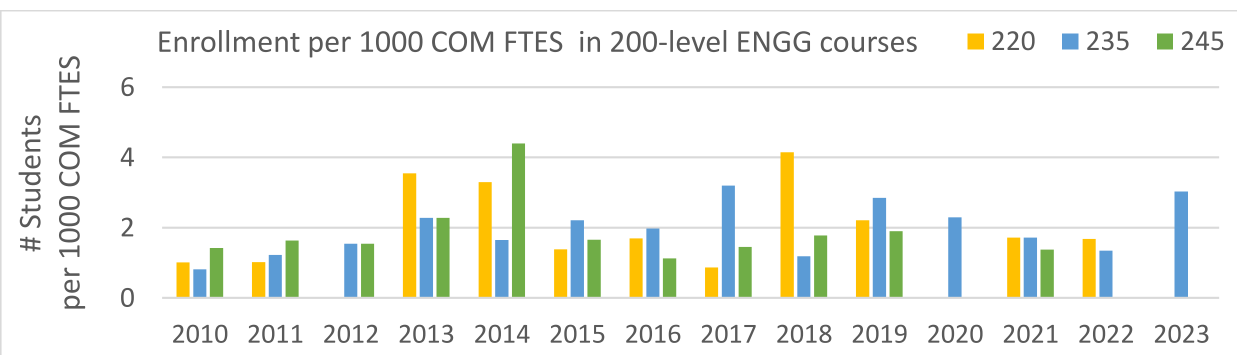
- Note that lowering standards in the pre-requisite Math and Physics courses could lead to higher enrollments in ENGG courses, but at the cost of lower ENGG success rates. A better strategy is to **provide greater support to struggling students in these early pre-requisite STEM courses**, which should improve both enrollment and success in higher level courses. In fact, the recent creation of companion courses in MATH 109 as a result of AB 705, along with initiatives to foster peer support within the STEM Learning Community, may have already started to increase ENGG enrollments. Extending such support structures to higher-level courses (e.g., MATH 123, PHYS 207A, etc.) via initiatives such as MESA, embedded tutors, etc., may lead to further gains during the next few years.

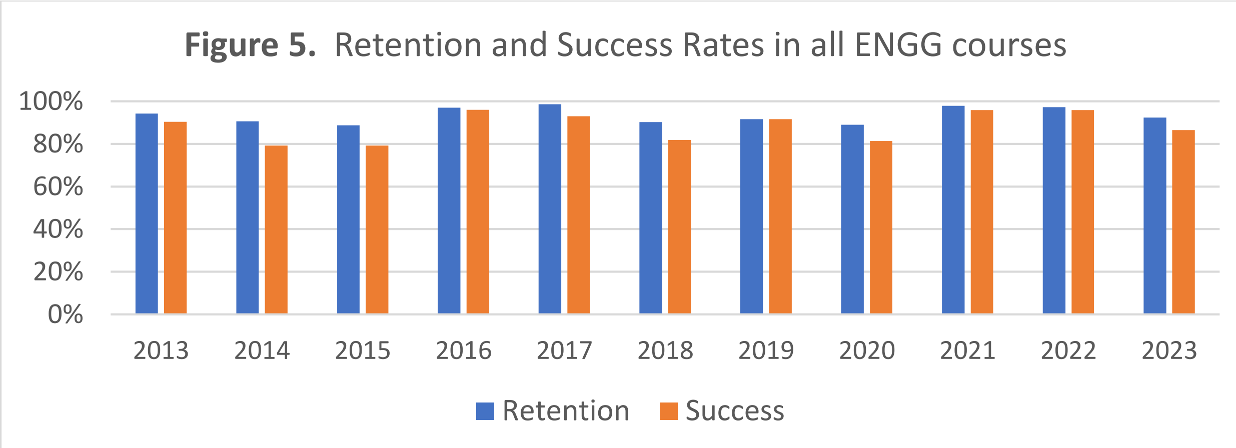
Figure 4. Trends in ENGG course enrollments.
Values represent census enrollments during academic years starting with year indicated, where 2023 includes only Fall 2023 (in bottom two graphs, 2022-2023 FTES was used for per FTES calculation).











Conclusions and Recommendations

- College of Marin has at least 146 students pursuing transfer as an Engineering/CS major (roughly 80 as Computer Science and 66 as another type of Engineering). The college offers a full set of lower-division math, science, and engineering courses needed by these students for successful transfer in these majors to nearly all UC and CSU programs. The ENGG courses, which represent the typical set offered by most CCCs, are aligned with statewide C-IDs and equivalent courses in most UC and CSU programs. Careful planning goes into the scheduling of all STEM courses to ensure optimal access to students from a variety of majors.

- Only a fraction of Engineering majors need to take any particular ENGG course. As a result, even though College of Marin's ENGG course enrollments are typical for a college of its (very small) size, they are usually in the single digits or low teens, and have been for decades. Fortunately, the courses have high retention and success rates, and COM students have historically been very successful in transferring to UC and CSU Engineering programs, producing a small but steady stream of B.S. Engineering graduates in CA who began their journey at COM.

- There have been a number of recent developments that may lead to higher ENGG course enrollments in the near future. **In order to strengthen the Engineering program, College of Marin should continue to promote these (and other) outreach and support initiatives:**

    - The college has initiated a MESA (Math, Engineering, Science, Achievement) program that seeks to increase first-generation low-income students pursuing transfer into calculus-based STEM majors. MESA's outreach and support activities will naturally attract more students into COM's engineering pathway, and should increase the success and persistence of students through the pre-requisite sequences, so that more of these students reach the ENGG courses.

    - Over the past few years, the department has promoted extracurricular activities for College of Marin STEM students such as a NASA-sponsored summer 'Space Grant' program at COM and NSF-sponsored research internships at prestigious universities (e.g., Stanford, USC, UCB, UCLA, etc.). These experiences have generated enthusiasm within the COM student community about Engineering and Computer Science as exciting career fields.

  - COM recently hired a new part-time instructor to teach some of the ENGG courses, replacing a part-time instructor who recently retired. The new instructor has considerable experience with both the teaching and the practice of engineering, including a longstanding professional relationship with NASA. It appears that she has been well received so far, and may be able to attract additional new students into the ENGG courses she teaches.

  - Computer Science and Computer Engineering programs have become highly impacted at the UCs and many CSUs. As a result, high school applicants who were denied admission as freshmen into these majors may look to College of Marin as their best alternative to pursue these degrees, and it seems likely that we will see increased enrollments in the courses for those majors. In fact, we have recently begun turning away waitlisted students in introductory programming (COMP) courses. **If feasible, adding more sections of these courses could increase the overall pipeline of Engr/CS students and thereby improve enrollments in the higher-level courses**.

- Another strategy to increase ENGG enrollments is to promote a culture within COM that encourages students to consider which courses they *COULD* complete before transfer, rather than which courses they *MUST* complete to transfer. Many COM students are tempted to seek the shortest path to transfer. As a result, they avoid courses that could be used toward their eventual B.S. degree, not recognizing that completion of these optional courses will reduce their time (and cost) at the university after transfer. (In other words, 3+2 is much cheaper than 2+3 when pursuing an engineering degree.) Repetition of that message by instructors, counselors, MESA staff, etc., might convince more students to take maximum advantage of COM's low cost and intimate classes.

- Despite the various activities above that might increase ENGG course enrollments slightly, it seems likely that they will remain in single digits or low teens for most of the courses. To provide clear direction for faculty and students, **the college should decide on some set of ENGG courses that it can commit to offer and run once per year without cancelling, despite these low enrollments.** That set could range from zero to all six ENGG courses. The following issues should be considered when deciding upon this set of courses:

  - Last-minute cancellation of courses (or even the threat of cancellation) is disruptive to students and instructors, and undermines confidence in the college's long-term commitment toward the program. If the college feels, for example, that it can support enrollments in the teens typical of 100-series courses, but cannot support the single-digit enrollments typical of 200-level courses, then we should no longer offer those courses and should communicate that clearly to students.

  - Although some students may eventually discover that they do not need particular ENGG courses to transfer in their desired major, the availability of those courses may have attracted them to College of Marin or to a particular major when they first enrolled in earlier math and science courses. **Lack of some courses from our regular offerings may deter far more students than the typical course enrollment might suggest.**

- **From an equity perspective, the college should try to maximize the number of ENGG courses we offer.** As mentioned previously, the students who are most likely to transfer without any ENGG courses are those that have high GPAs, transfer to elite programs (e.g., UCB and UCLA), and can afford to spend a third year at the university completing their degree. Conversely, **the students most in need of our ENGG courses are those who are less advantaged** in terms of academic preparation and financial circumstances. These students need to complete a greater percentage of lower-division requirements in order for their application to be competitive, as well as to complete the upper-division curriculum within two years after transfer.

- **For the ENGG courses that we do not intend to offer, the college should provide guidance to students regarding how to access equivalent courses at other CCs.** A number of CCs (e.g., Chabot College) offer articulated online versions of several ENGG lecture courses; however, some ENGG courses have lab components that students will likely need to complete in person. As noted above, some students will need these courses in order to transfer successfully and/or to complete their post-transfer studies within two years, so we should facilitate their access to whichever courses we do not offer ourselves.

- **If we do intend to offer most of the ENGG courses, the college should consider a future full-time faculty hire** that includes ENGG as part of the duties (e.g., Physics/Engineering, Math/Engineering, Computer Science/Engineering, etc.). Long-term stability in the instructor staffing of these courses is necessary to ensure quality and therefore reasonable enrollments. Since only one section per year of each course is offered, and since the courses span a very broad range of topics, it is more reasonable (from a workload as well as qualification perspective) to have multiple full-time instructors with partial load in ENGG rather than a single full-time instructor who attempts to teach all of the ENGG courses.

Contributors to this report

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