01 Sep 2022

# Accelerated BS/MS Program in Electrical and Computer Engineering

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# Accelerated BS/MS Program in Electrical and Computer Engineering

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## Abstract

The Electrical and Computer Engineering Department at Missouri University of Science and Technology implemented an Accelerated BS/MS Program in 2019. This program is designed to encourage and facilitate undergraduate majors in electrical and computer engineering to pursue a masters program. It is similar to engineering programs at other institutions that are identified with titles such as accelerated masters, combined BS/MS, and 4+1 options. It reduces the time needed for undergraduates to earn a graduate degree and exposes these students to research work. It provides a route for faculty to obtain quality graduate students and it builds enrollment for the department. This paper discusses the structure and the implementation of the first program of this type at Missouri University of Science and Technology. The experience of the initial electrical and computer engineering students in the Accelerated BS/MS program is described. While the number of students who participated is not large, the program provides a valuable option to the curriculum.

## Keywords

Curriculum, Graduate Education, and Career Paths

## Introduction

Engineering undergraduates benefit from curricular options by which they can tailor their educational paths. One type of option allows students to combine their undergraduate and graduate study and to accelerate the completion of a first graduate degree. These curricula options are identified by a variety of program names, e.g. accelerated masters, combined BS/MS, and 4+1 programs [1,2]. Common features are double-counting courses to satisfy both undergraduate and graduate degree requirements and a degree path with shortened time-to-completion. Both thesis (research-based) and non-thesis-based programs exist. Institutions adapt the details to the discipline and to their local situations [3-6].

The Electrical and Computer Engineering (ECE) Department at Missouri University of Science and Technology (Missouri S&T) implemented an Accelerated BS/MS Program in 2019. While the university has long offered opportunities for qualified undergraduates to take graduate courses during their last semester and to participate in research through various undergraduate project opportunities, these options do not formally admit the student to graduate study. The ECE Accelerated BS/MS Program was the first such program for Missouri S&T and other departments have developed similar Grad Track Pathways programs [7]. The programs have financial advantages and can reduce the time to obtain both the BS and MS degrees by at least a semester as compared to obtaining the degrees sequentially.

This work discusses the Accelerated BS/MS Program for electrical and computer engineering students at Missouri S&T. The objectives and structure of the program are described and compared to the traditional masters program. Survey results from participating students are given. The students related their interest in and experience with the program. This curricula option provides a valuable career path with benefits to the students and to the department.

## Accelerated BS/MS Program Description

The Accelerated BS/MS Program is designed to increase the career path options for undergraduates in the ECE Department. This alternative to the traditional masters path was implement with other curriculum options such as formal emphasis areas and dual-degree (undergraduate EE/CpE and CpE/CpSc). The faculty noted that few undergraduates in the program were continuing with a graduate degree although many indicated that they would eventually pursue a masters degree at least. Students often noted existing job offers, the time to complete a graduate degree, and financial considerations (e.g. "the company will pay for the degree"). Many students had not investigated the details on going on for a masters degree. The Accelerated BS/MS Program addresses these considerations.

Following the patterns of other institutions, the department developed its version of an accelerated program for any combination of EE and CpE programs with the following objectives.

- Provide financial and time-to-completion incentives for a masters degree.
- Extend time to complete the thesis research project.
- Increase graduate course options (extended period to take graduate courses).

Also, the program creates new opportunities to talk to student early in their studies about graduate school. Key features are that students must pursue the masters immediately after the BS degree and must take the thesis option. The faculty have an added mechanism for attracting the best students in the department and for building the graduate research activity.

The requirements for a masters degree did not change; the curriculum modifications were made for the undergraduate degree requirements. Students in the program are allowed to take graduate courses while an undergraduate; multiple courses are double counted for both the undergraduate degree requirements and the graduate degree requirements (initially this was six credit hours and was later changed to nine hours). The cost of these double-counted courses is at the undergraduate rate and the BS degree is not delayed. Also, students can start research activity as early as the junior year, hence student have an extra year or two to work on a research project.

From an institutional perspective, the program provides important benefits in addition to increasing graduate student enrollment. It gives an attractive curriculum element for undergraduate recruiting. It is a new avenue for introducing undergraduates to research with the possibility for continued PhD interest. It produces students with greater background and skills upon entering the workforce, i.e. these students have both a BS and MS. This latter benefit and the time-to-completion benefit could become more important if the department follows the trend to decrease hours for the BS degree from 128 hours to 120 hours.

## Accelerated BS/MS Program Implementation and the Student Experience

The Accelerated BS/MS Program is summarized in the flyer given in the Appendix. This option is promoted in the university curricula catalog, in the department handbook, in the department sophomore seminar, etc. The Accelerated BS/MS program was considered in the latest successful ABET evaluations for the EE and CpE degree programs. A key advising goal is to make undergraduates aware of the option as they finish their sophomore year. Students are qualified if they are at or beyond the junior level with a minimum of 18 credit hours of ECE coursework and a 3.5/4.0 GPA in these ECE courses.

The flowchart in Figure 1 shows the typical path through the Accelerated BS/MS Program. After deciding that graduate school is something the student has an interest in pursuing. At that point, the student should talk with an academic advisor. A discussion of all possible routes that can be taken toward an advanced degree should take place so that the student knows options and requirements. This discussion should take place fairly early in the student's career to get the full benefit from the program; realistically this discussion is best at the end of sophomore year. The

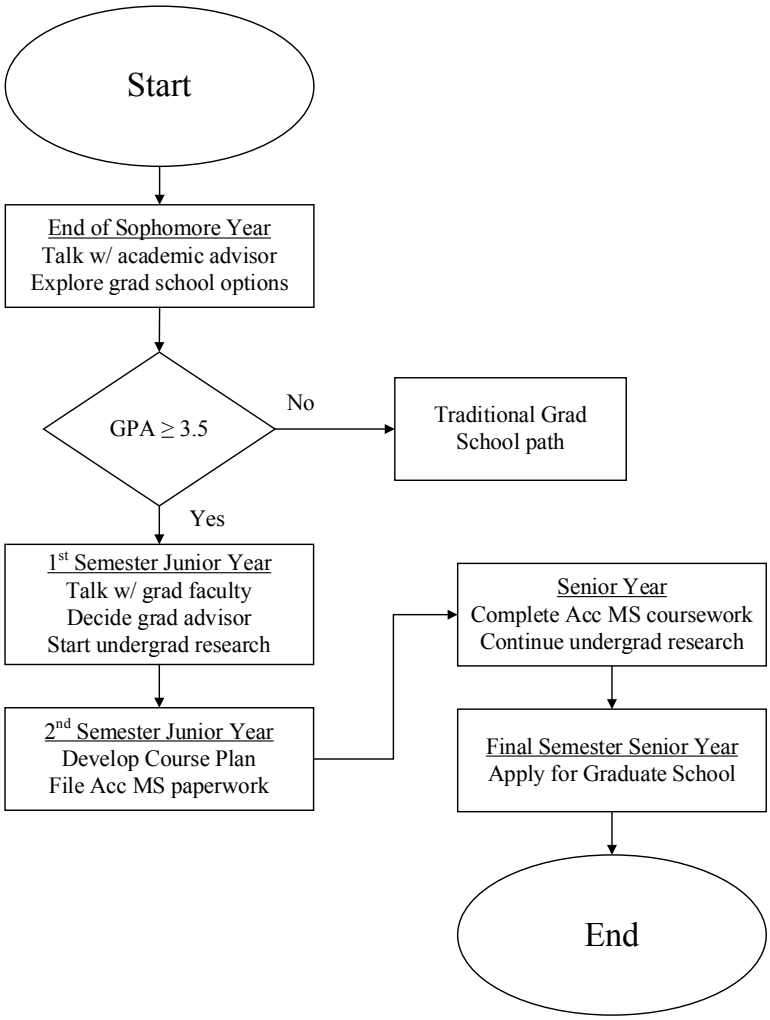


Figure 1. Accelerated BS/MS Flowchart

earlier the student can start graduate research work, the faster the masters degree can be completed. Additionally, the student will want to prepare a dossier for scholarship grants with consideration given for program participation. Of course, the student must maintain grades with a GPA at or above 3.5 to remain eligible. If the student is unable to maintain a high GPA, a more traditional graduate school path would need to be followed which includes entrance examination and a longer time to complete.

At the start of Junior year, the student will need to find a graduate advisor. This can only be done by due diligence. The student has to determine what field of study has interest, and then talk with faculty in those areas to see what specific work they are doing. The student should also consider undergraduate research to get a head start on the research component of the graduate program. This will help the student complete a masters degree in the shortest amount of time and to selected the best set of courses.

With their graduate advisor, the student would then develop a course of study with particular emphasis in identifying the three courses that will be part of the Accelerated BS/MS Program. Once these courses are identified, the paperwork to apply is filled out and submitted. The application is a single page listing the student, the advisor, and the courses to be taken as an undergraduate to count for graduate school. These courses will be applied toward both graduate school requirements and undergraduate requirements (typically fulfilling technical electives).

With the student enrolled in the program, classes can be taken and the research work started. Regular meetings with the graduate advisor should take place in order to maintain a smooth transition from undergraduate to graduate school and to make any course corrections to the proposed plan. Needed adjustments typically takes place during senior year but can happen earlier depending on the student. Students are not prevented from combining the program with other options such as formal emphasis areas, summer internships, etc.

In the last semester of undergraduate senior year, the student will then need to formally apply to graduate school. This application fixes the plan as well as formally applies the double-counted courses toward graduate school. As part of the program contract, the student promises to remain at the university and continue immediately toward a masters degree. If the student fails to apply or wishes to drop out of the program, the courses taken in the Accelerated BS/MS Program will revert to only counting toward the bachelors degree. With this approach, there are minimal considerations with regard to graduate processing of courses.

Since starting the program in 2019, eleven students meeting the eligibility requirements have entered the Accelerated BS/MS Program. Figure 2 shows the number of students accepted into the program by semester. Currently, six of the students have completed their undergraduate program and have started graduate school. Two students have completed graduate school and are currently working as design engineers.

As part of the research for this paper, a short questionnaire was sent to the students participating in the program. Of the eleven students, five replied. Below are the survey questions and the returned comments for each of the questions.

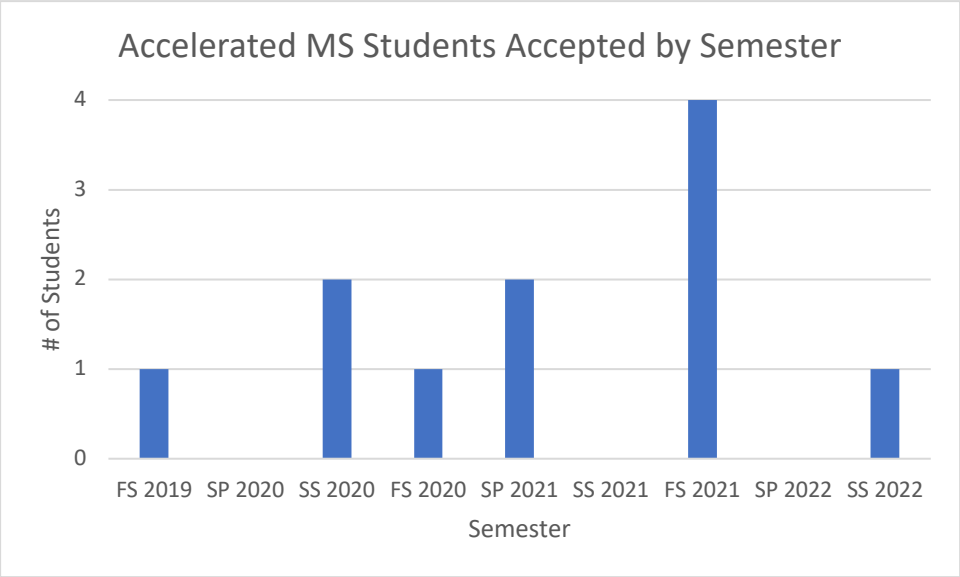


Figure 2. Accepted Accelerated BS/MS Students 2019-Present

*Question: How critical was the program in your decision to go to graduate school?*

- The accelerated program was actually critical for me in deciding to do [grad] school. I had two job offers, but one of them was in a location that I didn't care for, and the other job had work that I was not interested in. To me, I thought that the accelerated program would allow me to finish my MS in one year or a little more and would allow me to start my career sooner at more advanced level and higher salary and would allow me to do more interesting work.

- For my situation, the accelerated program was probably my only option for doing graduate school, so it was extremely critical for me. Having the opportunity to be able to do something like this program is truly a blessing.

- The accelerated program played a pretty decent part in me going to grad school. For me, I made the decision when I got my full time offer from Honeywell back in summer 2021. I looked at what I was offered as a starting engineer there and wanted a little more, in terms of salary and actual design that the job offered. I liked Honeywell as a company and work environment so I decided the accelerated program would help me jumpstart my career a little with Honeywell in a very short amount of time. Knowing I could get my masters in a year as opposed to a couple years helped me make the decision quicker. I also considered that another year in school is well worth it as opposed to taking night classes while having to work a full-time job and possibility of a family as well. Many people wait simply because their company will pay for the tuition later down the line. I had considered this as well but when I found out that the EMC lab could support me through research, I think I made the right decision doing it now.

- The accelerated program was probably the main reason I decided to go into grad school. Especially in conjunction with the dual enrollment, it wouldn't have been possible for me to go into grad school financially without it.

- The accelerated program was a critical factor in my decision to attend grad school. I did already have the drive to want to continue my education before learning about the program, but the program helped solidified my decision to continue onto grad school.

*Question: What was the primary reason for entering the program?*

- Getting two classes to count for both BS and MS degrees seemed appealing to me when I decided to enroll in this program. Also, a student could theoretically complete the entire MS degree in one year as a best-case scenario. In addition, I was not required to take the GRE to enter the MS program at Missouri S&T, and the acceptance into the MS program was basically automatic.

- I wanted to be done as soon as possible, while also being able to still gather the more in-depth knowledge over Electrical Engineering that comes with a graduate program.

- I outlined this mostly in the question above but as I mentioned, it was jumpstarting my career with better pay and with a position that would do more design work. I think marketing it this way to current undergrads would be a great way to get more people in the program as I've noticed people tend to want more designed based jobs and everyone wants more money.

- The main reason I wanted to do the accelerated program was because I believed I could do it and graduate on a reasonable timeline. I was on track to graduate in three years, so I figured that I could get the extra degree in the time it takes many S&T students to graduate with a BS. Additionally, the price was a huge factor as well. Being able to pay undergrad price for classes was extremely helpful.

- The reason I entered the program was to save time and money. I knew I wanted to go to grad school, and the option of completing my grad degree faster and cheaper was a huge bonus. Also, the ability to get a head start on my grad research and start formulating my thesis before undergrad graduation was also very helpful. I felt very prepared to enter grad school after finishing undergrad.

*Question: Did you feel you were prepared to take the graduate courses as an undergraduate?*

- As an undergraduate, it seemed like I was well prepared. The classes did have a little bit more work, but it was manageable as long as you stayed on top of it. I don't think that the graduate-level courses are that much harder than the undergraduate classes; yes, the grading might be more strict than undergraduate courses, but the difficulty also depends on the instructor.

- I'm not sure honestly. I haven't taken the two graduate courses yet (that's this Fall), but I feel like my time as an undergrad has definitely shown me how to problem solve and think through complex problems, while also giving me the fundamentals of electrical engineering that are going to be incredibly important for those classes. I'm truly excited for these two graduate classes this fall because I know it will push me to become a better student.

- I believe it was in Fall 21, I took EE5600 Interference Control. While the content of the class could be challenging, as my first graduate level course, I think I did fairly well. I got an A. While I didn't remember everything from Electromagnetics the previous semester, I was still prepared enough to go in and understand where many of the equations were coming from. From my experience, as long as the instructor of the course shows what they are trying to achieve, where it comes from, how to get to it, and the application behind it, any course, graduate level or not, is achievable. I also took EE6140 Advanced RF Measurement. This class had a unique challenge that I don't believe I was entirely prepared for. It required a lot of work outside class, specifically at the EMC lab. This was because the class revolved around real life measurement techniques of RF systems and we needed things such as high bandwidth oscilloscopes, >1GHz VNA, and other expensive equipment that the typical labs at EE don't have. While I did already do research at the lab, to come in and prepare for some of these measurements took time. Between other classes and campus commitments, it could be hard to find time to come in prepare for these experiments if I didn't finish them during the allotted lab hours. A typical grad student in this class would be at the lab for research more and would be able to better accommodate times to do measurements. I am glad I took the class as it helped me manage my time better and get in the lab more, some undergrads may have issues doing some of the more extensive work that could be required outside of class for grad level courses. This could include measurements for my case, simulations, or other types of assignments.

- Personally, I didn't find the graduate courses to be too much of a leap in difficulty from my harder undergraduate classes. They were certainly harder, but I would say that I was prepared for them.

- By the time I began my junior year, which is when I was eligible to enroll in grad classes, I felt prepared for the more rigorous grad coursework. It was a step up from the undergrad classes but having learned how to study and how to learn as an underclassman helped me succeed in the more difficult classes. They did require more effort and time than my undergrad work, but I knew I could succeed in the grad classes

*Question: Would you recommend the program to an undergraduate looking at graduate school?*

- If you interested in research, may want to work in R&D, or potentially want to get a Ph.D., I would recommend it. If you are not interested in research, I would not recommend the program. The decision honestly lies on whether or not you want to get a thesis masters or a non-thesis Masters

- Even though I truly haven't started it yet, I would absolutely recommend it because of how the program has been described to me. It's a great balance of studying as a graduate student while also giving you the opportunity to graduate as soon as possible.

- Definitely. I think I listed most of the benefits for me in the first question. A Masters degree puts you ahead of everyone else you are graduating with and if you can find a lab or other means to support you, I think everyone able should do the program at the time they finish their senior year since school and most of the topics are still in their mind. I think the

potentially free tuition and condensed time frame makes it well worth it considering the benefits that come out of it.

- I would absolutely recommend this program to undergrads, especially in conjunction with the dual enrollment. One thing I would add though, is that undergrads should know that it has to be the thesis masters, and should know about the process of writing a thesis, how to find an advisor, etc. A few friends of mine were planning on using accelerated masters but decided not to because they were unable to find an advisor doing research in their area of interest. For me, I happened to find an advisor, but I found the whole process of getting the credits and forms all filled out on their correct deadline confusing. I would maybe suggest a good document or resource that explains the accelerated Masters forms, dual enrollment forms, how they work together, and then the process of finding an advisor and what a thesis is like.

- I would 100% recommend the accelerated program to an undergraduate student looking to continue their education. However, I would like to preface that by saying I found the program to be A LOT of extra work. The added research on top of the undergrad and grad coursework made for very long, laborious, and challenging semesters. It also did not leave me a ton of time for extracurricular activities. Any student interested in the program should evaluate their current workload and mental capacity before making a decision. The program, as great of an opportunity it was for me, is not for everyone, even those who want to continue on to grad school.

## Discussion

ECE students seem pleased to have this career path option. While the sample size is admittedly small, those in the program recognize its incentives. The reduction in course cost and in time to completion seem to be the leading reasons for participation. The students believe that program participation can lead to higher pay and responsibility upon entering the workforce and that exposure to research at an early stage (when they are in the best place possible to study the material) is valuable.

The main student criticism of the program is the requirement for thesis research. Several students with interest in only non-thesis masters work have declined to participate. An expansion to non-thesis participation is unlikely since the ECE faculty want the program to support the department's research activity. The level of participation could be higher, but the program has only been available for three years. Understanding student participation in similar programs is a discussion area in the faculty community [8].

## Summary

The Accelerated BS/MS Program at Missouri S&T was implemented in 2019 and has had eleven participants to date. The program provides ECE undergraduates a curricular option for obtaining a masters degree with financial and time-to-completion incentives. Also, the students can perform their research over an extended period. The faculty and department benefit through greater opportunities to attract undergraduates to graduate work (and perhaps a subsequent PhD program) and through increased graduate enrollment. The students in the program confirm that its benefits were important factors in their decision to stay for the MS degree.

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## Appendix: Accelerated BS/MS Program Flyer

MISSOURI S&T

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

*Formerly University of Missouri-Rolla*

# ECE ACCELERATED BS/MS PROGRAM

If you are interested in graduate work, an accelerated BS/MS program is offered by the ECE Department for electrical engineering and computer engineering majors. This program allows eligible students to start a MS thesis program while an undergraduate with shared credit and tuition benefits. The degrees may be BS EE and MS EE, BS CpE and MS CpE, BS EE and MS CpE, and BS CpE and MS EE. The program requires continuous enrollment through the completion of the BS and the MS degrees.

The benefits of the program are:

- Undergraduate and graduate courses may be chosen with greater flexibility,
- Up to nine hours of 5000-level or above ECE coursework may be applied to both the BS and MS requirements,
- The classes taken for shared BS/MS credit may be taken at the lower undergraduate tuition rate,
- The GRE is not required for admission,
- Other graduate credit courses may be taken anytime after entering the program, and
- Work on the thesis project may begin before the BS requirements are completed.

To be eligible for the accelerated BS/MS ECE program, an EE or CpE undergraduate must be at or beyond the junior level with a minimum of 60 credit hours and must have completed 18 credit hours of EE and/or CpE courses at Missouri S&T with at least a 3.50 GPA in the ECE courses. To be admitted, the student must complete the program application and must have the recommendation of an ECE faculty member who agrees to serve as the graduate thesis advisor.

The BS-degree requirements are modified for admitted students such that selected EE or CpE Electives will be satisfied by nine-credit-hours of 5000-level or above ECE coursework. The courses must be identified as shared-credit courses. These nine hours of coursework will be taken as undergraduate credit, must be approved by the academic advisor, and may not be undergraduate research, special problems, or transfer courses (A co-listed course can only apply for these undergraduate requirements if it is under an EE or CpE registration. Note that the choice of EE or CpE registration may affect how a course can apply within an MS program.) All other MS degree requirements are not changed and the MS degree must be for the thesis option. The program may be combined with existing honors research and emphasis area options.

The formal program description is in the current undergraduate catalog for electrical engineering and computer engineering. See the ECE department coordinator for more information on eligibility, admission, etc.

**ECE Department Coordinator for Accelerated BS/MS Program**
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