Texas Tech Electrical Engineering Graduate Program Review

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The Department of Electrical and Computer Engineering at Texas Tech University has a growing and dynamic graduate program. In the last five years the number of graduate students has grown from 126 to 167. The number of doctoral students has increased from 35 to 46 (after a dip to 27 doctoral students in 2007). Unlike their peer institutions the graduate enrollment at Texas Tech is biased towards the MS program. The ratio of PhD students to MS students is approximately 1:3 at TTU while it is 3:2 for ISU and 2:1 for UNL. The graduate program in the department is administered by the Chair of the Graduate Studies Committee with support from one staff person and an admissions committee of seven faculty members.

The students can work with professors in several centers including

1. Center for Pulsed Power and Power Electronics (7 ECE faculty members)\(^1\)
2. Nano Tech Center (4 ECE faculty members)
3. Computer Vision and Image Analysis Laboratory (4 ECE faculty members)
4. Applied Vision Laboratory (1 ECE faculty member)
5. Wireless Communication Systems Laboratory (1 ECE faculty member)
6. Advanced Vehicular Engineering Laboratory (1 ECE faculty member)
7. Neuroimaging, Cognition, and Engineering Laboratory (1 ECE faculty member)
8. Microwave and Antenna Laboratory (2 ECE faculty members)
9. Program for Semiconductor Product Engineering (1 ECE faculty member)
10. Advanced Electronic Systems Engineering Program (1 ECE faculty member)
11. Nanophotonics (2 ECE faculty members)

\(^1\)numbers based on the department website
Of these groups, the Center for Pulsed Power and Power Electronics is by far the largest. Because of its size this center has a significant influence on many aspects, both obvious and subtle, of the graduate program. In light of its significance we will review its effect on the doctoral program in a separate section. As is the case for most US institutions the majority of doctoral students are foreign nationals. However, because the funding sponsors of the Center for Pulsed Power and Power Electronics require that students working on Center projects be US citizens, the overall population is less heavily biased to international students than is the case in their peer departments. In the overall graduate population the number of non-residents is 109 out of 167 students. There are only five Hispanic students among the 167 students. In a region where there is a large (almost 37 percent) population of Hispanics this seems to be a very low participation. This is especially striking given that the there is a significant (albeit small - about 16%) number of Hispanic undergraduate students in the department.

Students awarded Research Assistantships are assigned to an advisor at the time of their admission. The rest are initially supervised by the graduate advisor. While there have been very few occasions where a student has changed an advisor, where it has happened the change has happened smoothly and without rancor. This indicates a cordial relationship among the faculty and a genuine concern on the part of the faculty for the well being of the graduate students. Students on research projects are encouraged to write papers and present their work at conferences. While there is no travel support from the department, the faculty are willing to commit sufficient funds from their various research programs to allow student travel. Depending on the particular program, students are also encouraged to take part in the proposal preparation process.

The department also has an Industrial Masters program, funded by Texas Instruments, which is currently supporting twenty students. While the program is focused on MS students it also provides a valuable source of prospective PhD students.

There are very few students on teaching assistantships within the department. The teaching assistants are not provided with any training to develop their teaching skills. This may be because, except for the TA’s assigned to the project labs, the teaching assistants mainly grade. They are required to have office hours but these do not seem to be utilized by the undergraduates. If they have not already done so, the department may consider setting up a Resource Room where graduate TA’s would spend a certain number of hours per week helping undergraduates with their classes. This would provide the graduate students some teaching experience while also helping the undergraduates. None of the doctoral students we met were interested in a teaching career after graduation. A reason for this may be the absence of teaching experience for doctoral students.

The department has an excellent level of research funding with about two thirds of the funding obtained by faculty in the Pulsed Power group. The department generated close to two million dollars in overhead return in 2010, of which 20% went to the principal investigators. This rate of return is generous when compared to many institutions and represents a significant resource to sustain and grow the graduate program.
The normal faculty teaching load is two courses per semester. New faculty teach one course per semester in the first year. It is understood that there is an effort underway to reduce the teaching load to three per year for faculty involved in research. This is a very necessary effort as it is difficult to envision growth in the doctoral program when faculty are teaching two courses per semester.

In summary, the department has an excellent graduate program with devoted faculty, conscientious administration and enthusiastic students. Given the very heavy load that the department and its faculty labor under it is difficult to see how they can further improve their national and international standing without infusion of fresh resources. However, if resources were to be made available the department is in an excellent position to take advantage of them. In the following we try to provide some suggestions for further improvements to the program.

1 Administration

The graduate program is administered by a Graduate Chair, Professor Richard Gale, with one support staff. The admission process involves review of application files by up to seven faculty members. The graduate chair runs the admission process, serves as the advisor for the approximately 75 students in the non-thesis option and is the advisor for all students who have not yet selected a research mentor. He is also responsible for developing plans to improve the program. This duty is in addition to teaching two courses per semester and directing the industrial MS program. While Professor Gale deserves a great deal of credit for doing a difficult job very well - much better than can reasonably be expected - the situation is not tenable. During the last year the department reviewed more than five hundred applications with the graduate student population currently standing at 167. In order for Professor Gale to devote attention to what should be one of the most important tasks facing the graduate program - planning for the future - an effort has to be made to reduce his other duties. A few possible ways this could happen would be the following:

- The obvious thing to do is to provide more staff support for the graduate program. It is not clear that the staff person supporting the graduate program is only responsible for the graduate program. The graduate program requires significant attention and it is important that this person be responsible only for the graduate program. If this support person also has responsibilities outside of the graduate program then it might be wise to hire another person with sole responsibility towards the graduate program.

- The graduate school could provide some much needed support during the application process. It is my understanding that the current process does not permit recommendations to be provided on line. This can easily be remedied and will provide some relief in terms of book keeping. Another possibility would be for the graduate school to provide summary information about the applications. A spreadsheet listing the
students’ test scores, undergraduate institution etc. would allow the department to streamline their review process.

- The incoming graduate students who do not have a faculty mentor should be provided a temporary mentor from among the faculty. While in our meeting several students expressed their appreciation for Professor Gale’s willingness to spend whatever time with them that was required, it was also clear that many of the students did not even consider the option of asking faculty for advice.

- The teaching load of the Graduate chair needs to be reduced or he should be provided some summer support. At Nebraska the Graduate chair gets one course relief per year, along with dedicated staff support.

It is necessary that some of the administrative pressure be relieved so that the Graduate Chair can spend more time, with assistance from the graduate committee, to develop a strategic vision for the program. Much as exercises in developing strategic visions are maligned, without some level of formal planning the program cannot move beyond its current level.

There is also a need for a better communication protocol between the department and the graduate students. The use of the web is a double edged sword when communicating information. Because the information is available on the web the department assumes that the graduate students are aware of the information. However, because many of the graduate students do not know where this information is available they never access it. This engenders frustration on the part of the department who feel that the information necessary has been provided, and befuddlement on the part of the graduate students who are simply not aware of essential information. This kind of miscommunication can lead to unpleasant consequences with each side blaming the other\textsuperscript{2}. Printed handouts given to the graduate students when they first enter the program which highlight essential information and the responsibilities of the students would be a very useful supplement to the current efforts of the department. Another option could be to set aside a fifteen minute time slot once every semester in the graduate seminar class for dissemination of information.

2 Recruitment

The department has done an excellent job of recruiting its own undergraduate students. The 150 credit hour combined BS/MS program seems to be very successful in helping the department encourage capable students to stay on for an MS, and possibly a PhD degree. It has also used the Industrial MS program to good effect, even recruiting students from Monterey Tech in Mexico. The department also conducts outreach to encourage especially promising applicants to come to Texas Tech. Despite these successes this is one area in which the department, given additional resources, could do much more.

\textsuperscript{2}for an extreme fictional case see D. Adams, \textit{A hitchhiker’s guide to the galaxy}
Rather than simply focusing on students who self identify as being interested in Tech by filling out an application there should be an effort to get students to apply to Texas Tech. This could be especially promising with respect to foreign students. There are a significant number of foreign born faculty in the department who possibly still have connections with universities and colleagues in their countries of origin. Resources could be made available to these faculty to go on recruiting trips to highly ranked Universities in their countries of origin.

The department may be passing up opportunities to get outstanding students from institutions which may not be in the top tier but are still outstanding. This is especially true for students from populous countries like India and China. The graduate school could help the department to identify such schools in a number of ways. The graduate school probably has its own information networks which could identify particular institutions as being the source of high quality students. The graduate school could also develop a database of students coming to Texas Tech from various institutions along with a record of their success in the program at Texas Tech. I am sure the department currently does focus more attention on schools from which it has received outstanding students. However, their net is not as wide as the one available to the graduate school - institutions which graduate top notch mechanical engineering students would, with high probability, also graduate top notch electrical engineering students. The information they provide can be very useful to the department in its recruitment efforts.

Finally, for whatever reason the department has not been very successful in recruiting underrepresented minorities to the graduate program. The lack of any significant Hispanic component in a state which is more than third Hispanic is both a problem and an opportunity. A similar case can be made for the underrepresentation of women in the graduate population. The seeming lack of women and Hispanics among the students in the 150 hour combined BS/MS program was especially striking. This is one area where a departmental focus on recruitment would be highly productive on many levels.

3 Training

Graduate students on the whole are well trained by the faculty. One glaring omission in their training is the lack of opportunity for students to take graduate-only courses. It is understandable for the department to cross-list the vast majority of the graduate courses to permit undergraduate students to take the classes. It allows for greater enrollment in the classes which in turn allows more classes to “make.” However, the lack of graduate-only classes deprives the students of the type of interaction with the instructor that is only available when the instructor does not have to “dumb down” the material in order to accommodate the undergraduates in the class. One student in our meeting described how the instructor in a graduate power systems course spent time explaining the elementary undergraduate concept of a transformer turns ratio. I understand that there is a requirement that the graduate students in a cross-listed class be required to perform at a higher
level that the undergraduates. However, according to the students, this rarely entails more than an additional question on the exam for the graduate students. There is an issue of resource involved here as well. Given that the faculty are already teaching a full load (in my opinion, more than a full load) making some of these classes graduate-only will reduce the options available to the undergraduate students. However, this is an issue that has to be addressed if the department is to advance along its chosen path. In particular graduate only classes are excellent recruiting tools for the doctoral program. If the doctoral program is to grow the department will have to be given the resources necessary to develop graduate-only classes.

4 Pulsed Power

The Center for Pulsed Power and Power Electronics is the largest and best funded research group in the department. Based on the numbers provided by the department, the Center is responsible for two thirds of the research funding in 2010. Due to its size and productivity the Center exerts a great deal of influence on the doctoral program. For the most part the influence of the Center is positive. The funding allows the Center to support a significant number of graduate students. The active participation of the graduate students in the Center’s research and publishing activities sets a benchmark for other students. The involvement of the faculty with the graduate students also provides a standard for the interactions of other groups. The post-docs actively interact with the graduate students providing valuable training for the students. However, the Center also poses some possible problems for the future of the graduate program.

By the nature of its funding, the Center is restricted to hiring US citizens. Also by the requirements of the funding sources much of the research conducted by the Center is in labs not accessible to other graduate students. This restricts the students in the Center from interacting with the graduate student population of the department as a whole, and hinders their learning from their peers. In an increasingly globalized world, exposure to interaction with a diverse population is a significant aspect of graduate training and is the hallmark of top tier research universities. The students in the Center are deprived of this aspect of a graduate education. It is important that the faculty and department be aware of this and develop strategies to ameliorate the effects of this segregation. This could be attempted by providing other venues for collaboration and interaction between all students in the program such as seminars and common classes. The Center could also try and provide some diversity by intensifying its efforts to recruit female students and students of Hispanic origin - neither category seems to be represented in any number in the Center’s graduate population.

The Center also exerts a major pull on the undergraduates. From what could be seen almost all the combined BS/MS students were part of the center. If the rest of the faculty see the combined program as simply a feeder for the Center for Pulsed Power and Power Electronics their commitment to the program will degrade over time. This is not good for
the program or the department. In our short visit it was not possible to reliably identify the reason for this though one assumes the higher level of assistantship support provided by the Center plays a role. Whatever the reason, this is an issue the department should monitor in order to head off any untoward effects.

5 Conclusion

The department should be commended for developing and maintaining an excellent program. Opportunities exist for further improving the program. However, this will require additional resources and support from the University.