

**Institutional Effectiveness
2023-2024**

Program: Engineering PhD

College and Department: College of Engineering

Contact: Dr. William Eberle

Mission:

The PhD program is a research degree and aims to enhance research quality and external recognition. The program goal has evolved to provide increasing prospects for the students to focus on research in five concentration areas as well as opportunities to pursue interdisciplinary research involving one or more of these specializations.

Description of Program:

The College of Engineering (CoE) at Tennessee Tech University (TTU) first began offering a Doctor of Philosophy in Engineering (PhD-Engr) degree in 1971. The PhD-Engr is a single, college-wide degree for all departments. However, students pursuing this degree will do so in a concentration area, listed below, hosted by a CoE department. The college-wide program also allows students to develop an interdisciplinary research topic that cuts across one or more of these concentrations.

PhD Concentrations	Host Department
ChemicalEngineering	Chemical EngineeringDepartment(CHE)
CivilEngineering	Civil and Environmental Engr. Dept.(CEE)
ComputerScience	Computer Science(CSC)
Electrical &ComputerEngr.	Electrical & ComputerEngineering(ECE)
MechanicalEngineering	Mechanical Engineering Department(ME)

Purpose of the PhD Program:

The purpose of the Ph.D. Program is to provide students with an opportunity for advanced studies and research in the field of engineering and computer science. As a research-based degree, the focus is on developing the independent learning skills of students in preparation for advanced-level, research-focused employment in industry or academia.

Attach Curriculum Map (Educational Programs Only):

Attached Files: See Appendix 1

PO1: Comprehensive, interdisciplinary, research-intensive training environment

Define Outcome:

Provide a comprehensive, interdisciplinary, research-intensive training environment for student development.

Assessment Methods:

Provide a map of the curriculum for each concentration, including their frequency, and titles of courses so that the diversity of course offerings can be analyzed.

Criteria for Success (Thresholds for Assessment Methods):

List of course offerings, including their frequency and titles. Number of course offerings will vary among the concentrations due to the wide range in the number of PhD students. Courses at the 5xxx/6xxx level should be offered at least once every 2 years, and courses at the 7xxx should be offered at least once every 3 years. This is so that a PhD student - which normally takes 3-5 years - will be able to take any course during their time in the program.

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning

Results and Analysis:

Refer to Appendix 2, Course Offerings and Frequency.

Number of course offerings will vary among the concentrations due to the wide range in the number of PhD students. Courses at the 5xxx/6xxx level should be offered at least once every 2 years, and courses at the 7xxx should be offered at least once every 3 years. This is so that a PhD student - which normally takes 3-5 years - will be able to take any course during their time in the program.

Attached Files: See Appendix 2

Use of Results to Improve Outcomes:

No actions were taken during the planning year designed to impact performance. This next year, would like each of the departments to revisit their course offerings, as most of them are just Directed Independent Studies.

PO2: Increase Average Completion

Define Outcome:

Increase the average number of students completing the PhD program to 20 per year.

Assessment Methods:

3-YR AVG PhD Degrees Conferred: Three-year rolling average of number of students graduating per year is a better indicator of trends than year-to-year data, which may be subject to fluctuations.

Criteria for Success (Thresholds for Assessment Methods):

3-YR AVG PhD Degrees Conferred of at least 20 (rolling average). This number was chosen because it would represent a 15% increase over the previous 3-year rolling average, which would represent healthy growth for the college.

Link to 'Tech Tomorrow' Strategic Plan:

2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

3-YR AVG PhD Degrees Conferred of at least 20 (rolling average). This number was chosen because it would represent a 15% increase over the previous 3-year rolling average, which would represent healthy growth for the college.

In the following table, the first column represents when the Ph.D. student started in the program. According to Institutional Effectiveness, the 2008-2009 & 2009-2010 cohorts had classification issues, and thus were removed from this data. The “ENR 2024” column identifies students who are still enrolled as of the end of the Summer 2024 session. Starting with the 2020-21AY, the “ENR 2024” numbers are significant (over 50% of the population), so they are not included in this report. Going forward, we will restrict the years to more than 4 years from the current academic year, given that most PhD students graduate in 3.5-4 years.

Cohort Starting Academic Year	#COHORT	#AWARDEES	ENR 2024	AVG Time to Completion
2010-11AY	12	10		4.48
2011-12AY	10	6	1	5.07
2012-13AY	18	12		4.52
2013-14AY	18	9		5.05
2014-15AY	69	38	1	4.77
2015-16AY	56	27		4.77
2016-17AY	51	25	8	4.63
2017-18AY	36	17	4	4.72

2018-19AY	97	67	8	4.20
2019-20AY	27	13	3	3.37

Use of Results to Improve Outcomes:

In order to improve the average time to completion, we will look at implementing a tool for tracking student progress. Adding automated notifications would provide the students and their faculty advisors with reminders of their progress.

PO3: Increase the percentage of graduates taking positions in academia.

Define Outcome:

Increase the percentage of graduates taking positions in academia.

Assessment Methods:

Provide a percentage of students taking jobs in academia based upon exit surveys.

Criteria for Success (Thresholds for Assessment Methods):

The reason for this metric is that by putting more students into academia, we can (1) improve the visibility of our program, and (2) help with the national shortage of Ph.D. graduates in academia. Using the results from exit surveys, we hope to achieve a 10% matriculation into academia.

Link to 'Tech Tomorrow' Strategic Plan:

2.B Research, Scholar, Intellect, and Creativity, 4.C Network of Scholars

Results and Analysis:

The reason for this metric is that by putting more students into academia, we can (1) improve the visibility of our program, and (2) help with the national shortage of Ph.D. graduates in academia.

	2022-2023	2023-2024
# Ph.D. Graduates	14	21
# Taking Jobs in Academia	5 **	6
% Taking Jobs in Academia	36%	29%

*** Only started collecting job information in Spring 2023*

Starting in Spring 2023, surveys were sent to all students who defended their dissertations. In the survey, the student provides their post-graduation plans, including where they will be working, what type of organization (academia or industry), their title, etc. While the time

between graduation and job was too short to collect much meaningful data regarding their post-graduation work (which was done by analyzing the student's CV at the institution they are working at), in 2023-2024, we continued to seek responses to post-graduation plans, including whether or not they took a job in the field of academia. It should be noted that while the number of "Ph.D. Graduates" is accurate, the number taking jobs in academia is dependent upon the students responding to the survey. LinkedIn was also used to validate PhD graduates who went into Academia.

Use of Results to Improve Outcomes:

As this is a new metric being collected, no new additional actions are occurring in the next planning year.

SLO1 - 4: Academic Competencies

Define Outcome:

SLO 1: Demonstrate Breadth and Depth of Knowledge

The student should demonstrate depth of knowledge in the specific area of his/her research topic.

SLO2: Independent Academic Research

The student should gain experience in doing independent academic work and research.

SLO3: Ability to Identify and Define Topic

The student should demonstrate his/her ability to identify and define the research topic.

SLO4: Contribute to Existing Knowledge in the Engineering Field

The student's research work should contribute to the existing knowledge in the engineering field.

Assessment Methods:

SLO1: Every PhD student must complete a Program of Study (PoS) before completing 15 credit hours of coursework. The PoS is developed under the guidance of the student's Advisory Committee (AC). The courses specified in the PoS ensure the depth of knowledge needed for the research topic. The student will develop a research topic with the help of her/his major advisor and the AC. In developing the research topic, students will also develop the depth of the knowledge needed in their field.

In addition, the depth of knowledge must be demonstrated through the comprehensive examination process. The comprehensive examination involves an examination of the depth of the specific knowledge in the field of study.

Completion of the student's research culminates in a written dissertation examined by the AC and defended publicly through an oral examination (SLO 1-4).

SLO2: The ability to conduct independent academic research must be demonstrated through the **comprehensive examination** process. Completion of the student's research culminates in a **written dissertation** examined by the AC and defended publicly through an oral examination (SLO 1-4).

SLO3: The ability to define an appropriate research topic for a dissertation must be demonstrated through the **comprehensive examination** process. The comprehensive examination involves an examination of the depth of the specific knowledge in the field of study and a written proposal describing the research the student will conduct. Completion of the student's research culminates in a **written dissertation** examined by the AC and defended publicly through an oral examination (SLO 1-4).

SLO4: Through the **comprehensive examination** process, students must establish their clear and unique contributions to their field of study through an oral presentation of their research topic.

Completion of the student's research culminates in a **written dissertation** examined by the AC and defended publicly through an oral examination (SLO 1-4).

Criteria for Success (Thresholds for Assessment Methods):

SLO1: 100% of students have filed a **Program of Study**, as no student should be allowed to proceed without a plan early enough in their program.

95% of students who take the **Comprehensive Exam** pass on their first try. This is a difficult exam, but most students should be well prepared, with help from their Advisor, to pass on their first attempt. Only a very small handful are anticipated to not pass on their first attempt, hence the reason for this high percentage.

95% of students pass their **written/oral dissertation** on their first try. This is the most difficult accomplishment for a student, but, again, a student should be well prepared by their Advisor to pass on their first attempt.

SLO2: 95% of students who take the **Comprehensive Exam** pass on their first try. This is a difficult exam, but most students should be well prepared, with help from their Advisor, to pass on their first attempt. Only a very small handful are anticipated to not pass on their first attempt, hence the reason for this high percentage.

95% of students pass their **written/oral dissertation** on their first try. This is the most difficult accomplishment for a student, but, again, a student should be well prepared by their Advisor to pass on their first attempt.

SLO3: 95% of students who take the **Comprehensive Exam** pass on their first try. This is a difficult exam, but most students should be well prepared, with help from their Advisor, to pass on their first attempt. Only a very small handful are anticipated to not pass on their first attempt, hence the reason for this high percentage.

95% of students pass their **written/oral dissertation** on their first try. This is the most difficult accomplishment for a student, but, again, a student should be well prepared by their Advisor to pass on their first attempt.

SLO4: 95% of students who take the **Comprehensive Exam** pass on their first try. This is a difficult exam, but most students should be well prepared, with help from their Advisor, to pass on their first attempt. Only a very small handful are anticipated to not pass on their first attempt, hence the reason for this high percentage.

95% of students pass their **written/oral dissertation** on their first try. This is the most difficult accomplishment for a student, but, again, a student should be well prepared by their Advisor to pass on their first attempt.

Link to 'Tech Tomorrow' Strategic Plan:

2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

Comprehensive Exams

	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
# Ph.D. Students	15	35	23	15	17	14	20
# Pass on first attempt	93.3%	100%	100%	100%	100%	100%	95%

From 2018-19 to 2022-23, 100% of students who took the Comprehensive Exam passed on their first try. This is a difficult exam, but most students should be well prepared, with help from their Advisor, to pass on their first attempt. This year we had one student not pass the comprehensive exam, which was the first time since 2017-2018.

Written/Oral Dissertations

This is a new metric for this SLO, so we only started collecting this information with the Fall 2023 semester.

	2023-24
# Ph.D. Students	21

# Pass on first attempt	21
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To evaluate these 4 outcomes, the only two mechanisms currently being used are students' comprehensive exams and their written/oral dissertations. These appear to be the best sources of measuring SLO 1-4, as they involve the evaluation of a student on their depth of knowledge, their ability to do research, and whether or not they will be able to contribute to existing knowledge. Given that all students passed their Dissertation on their first attempt, that shows the quality of the students and the preparation provided by their Advisor.

Use of Results to Improve Outcomes:

Comprehensive Exam: *No actions were taken during the planning year designed to impact performance, and none are planned for the next year.*

Written/Oral Dissertations: *As this is a new metric being collected, no new additional actions are occurring in the next planning year.*

SLO5: Demonstrate Contribution to Society

Define Outcome:

The student should demonstrate the ability to contribute to the achievement of societally relevant outcomes.

Assessment Methods:

Many Ph.D. students are funded through research grants, of which there are many times broader/societal objectives. Working on these funded research projects will expose the student to the societal benefits of their work.

Attached Files: See Appendix 3

Criteria for Success (Thresholds for Assessment Methods):

In 2022-2023, 32% of Ph.D. students were funded by external research grants. For 2023-2024, we have set a goal of 50% of students as we continue to strive to move up a Carnegie classification when it comes to funding, and, directly related to this SLO, expose more of our students to societally relevant research.

Link to 'Tech Tomorrow' Strategic Plan:

2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

This is a new SLO metric, so we only started collecting this information in the Fall 2022 semester. The idea is that students actively involved in research are adding to societal outcomes.

	2022-23	2023-24
# Ph.D. Students Funded on External Research Grants	38**	78
# Ph.D. Students***	119	120
% Ph.D. supported on external research grants	32%	65%

*** These are Spring/Summer numbers only*

**** These are Fall numbers as I do not have access to the total number of unique PhD students for an academic year (i.e., Fall/Spring/Summer). I would expect the total number to be a bit higher as there are spring/summer entries that were probably more than fall graduates.*

Our goal for **2023-2024** was to increase the percentage of Ph.D. students funded on external research grants to **50%**. In **2023-2024** we reached **65%**, which more than doubles that previous year's percentage. Clearly, we had a significant jump in the number of externally funded PhD students, which can be tied to the record number of grants and grant funding that was received in **2023-2024**.

Use of Results to Improve Outcomes:

As this is a new metric being collected, no new additional actions are occurring in the next planning year. Want to see more of a three-year rolling average to see if this is a blip, and if it will stay with the potential growth that we are anticipating in PhD enrollments.

Summative Evaluation:

The College of Engineering has in place a framework/process for the continual improvement of the Ph.D. in Engineering program to ensure its learning outcomes are met and that the outcomes are themselves updated as necessary to reflect any changes that may occur in vision, mission, or the needs of the educational and research community.

Assessment Plan Changes:

Information that is regularly collected for the evaluation of program objectives and learning outcomes as outlined in the previous sections of this report. As responses to the identified results, changes implemented in **2023-2024**, or planned for **2024-2025**, are as follows.

Increase Number of PhD Students in the Program (P02)

In order to help improve this metric (*Increase the rolling average number of students completing the PhD program to 20 per year*), we will be exploring 2 initiatives this year:

-In July 2024, we rolled out a social media marketing campaign (Facebook and Instagram) in India. Using a company called Study College, we set out to target potential graduate students who would be interested in coming to Tennessee.

-In the fall (2024), we will be attempting to come up with a free/low-cost healthcare option for PhD students who are funded on assistantships. This did not pass last time when it included all graduate students on assistantships, so this time we will target PhD only students. Having this available to them will provide us access to more students.

List of Appendices:

Appendix 1: Engineering PhD Curriculum Map

Appendix 2: PO1 Results- Course Offerings and Frequency

Appendix 3: SLO5 Results - College of Engineering PhD Program Oral Defense and Dissertation Assessment Form

Appendix 1: Engineering PhD Curriculum Map

Coursework	Student Learning Objectives				
	Demonstrate Depth and Breadth of Knowledge	Gain Experience in Independent Academic Work and Research	Identify and Define the Research Topic	Contribute to Existing Knowledge	Communicate Effectively
6XXX and 7XXX Coursework*	X		X		
7980 Directed Study	X	X			
7990 Research and Dissertation	X	X	X	X	X

Appendix 2: PO1 Results
Course Offerings and Frequency

Appendix 2: Course Offerings and Frequency

Chemical Engineering

Course # Course Names	F17	F18	S19	F19	S20	F20	S21	F21	S23
CHE 5510 Advanced Math for Engineers	x	x	x	x	x	x	x	x	x
CHE 6010 Advanced ChE Thermodynamics				x		x		x	
CHE 6040 Intermediate Fluid Mechanics	x								
CHE 6210 Advanced Kinetics			x		x				x
CHE 6920 Chemical Engineering Graduate Seminar	x	x		x		x		x	
CHE 6810 Special Topics (multiple offerings each year)	x	x	x	x	x	x	x	x	x
CHE 7970 Special Topics (multiple offerings each year)	x	x	x	x	x	x	x	x	x
CHE 7240 Advances in Fuel Cell Electrocatalysis									
CHE 7980 Directed Study (multiple offerings each year)		x			x				

Appendix 3: SLO5 Results

College of Engineering PhD Program Oral Defense and Dissertation Assessment Form

College of Engineering PhD Program Oral Defense and Dissertation Assessment Form

Candidate Name:

Engineering discipline:

Committee Member

Faculty

Student

(Please check one)

Date:

Evaluation of Oral Presentation

Oral Presentation Type (circle): Proposal Defense Dissertation Defense

Graduates of the PhD program must be able to communicate their ideas effectively with their technical peers and with others outside their discipline. Please assess this candidate's oral presentation and written work using the following scale:

<u>Not</u> <u>Acceptable</u>	<u>Below</u> <u>Expectation</u>	<u>Meets</u> <u>Expectation</u>	<u>Above</u> <u>Expectation</u>
1	2	3	4

- 1 2 3 4 **Content:** appropriate, complete, concise, and logically organized; problem, approach and results clear; appropriate use of time.
- 1 2 3 4 **Visual aids:** readable and clear, concise wording, effective use of graphics, appropriate amount of information
- 1 2 3 4 **Presenter:** appears well-prepared, vocabulary technically correct and audience- appropriate
- 1 2 3 4 **Presentation mechanics:** volume of voice is good, good enunciation, appropriate speed in delivery; free of hesitations, distracting mannerisms; good poise, eye contact
- 1 2 3 4 **Responses to questions and comments:** appropriate, direct, and complete

Evaluation of Dissertation Document

- 1 2 3 4 **Quality of English:** good grammatical form, voice, tense, punctuation. Concise presentation
- 1 2 3 4 **Technical content:** clear description of problem, state-of-the-art, technical approach, and results; relevant and timely references
- 1 2 3 4 **Technical writing:** good organization; clear description of problem; clear figures and tables