Institutional Effectiveness
2022-2023

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
Chemical Engineering	Chemical Engineering Department (CHE)
Civil Engineering	Civil and Environmental Engr. Dept. (CEE)
Computer Science	Computer Science (CSC)
Electrical & Computer Engr.	Electrical & Computer Engineering (ECE)
Mechanical Engineering	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): *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 map of curriculum.

Criteria for Success (Thresholds for Assessment Methods):
List of course offerings and frequency of their offerings.

Results and Analysis:
Refer to attachment, Course Offerings and Frequency.

Use of Results to Improve Outcomes:
No actions were taken during the planning year designed to impact performance, and no new actions are occurring in the next planning year.

PO2: INCREASE AVERAGE COMPLETION

Define Outcome:
Increase the average number of students completing the PhD program to 20 per year by 2022-2023.

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 20

Results and Analysis:
Students who go into academia and do research will produce various forms of accomplishments: mentor students, research, grants, publish papers, etc. To capture this information, information from these student's academic/research websites will be collected to include the following (since they graduated): number of graduate students mentored; number of external research grants as PI or co-PI; and number of peer-reviewed publications.

The following represents summary information regarding Ph.D. students who went into academia after graduation. This is a new PG, and data collection did not start until Spring 2023. Thus, most numbers are low (if not zero), because former students have not had time to start their research at their academic institution. Since this is a new, post-graduation metric, we expect the numbers to go up in next year's report.

	2022-2023
# Entering Academia	**6**
# Grad Students Mentored	**0**
# External Research Grants as PI/Co-PI	**0**
# Peer-Reviewed Publications	**19**

Use of Results to Improve Outcomes:
No actions were taken during the planning year designed to impact performance, and no new actions are occurring in the next planning year.

SLO1: DEMONSTRATE BREADTH AND DEPTH OF KNOWLEDGE

Define Outcome:
The student should demonstrate breadth of knowledge in the discipline and depth in the specific area of his/her research topic.

Assessment Methods:
1. ***Program of Study***: Every PhD student must complete a Program of Study (PoS) prior to completing 15 credit-hours of course work. The PoS is developed under the guidance of the student's Advisory Committee (AC). The courses specified in the PoS ensures the depth of knowledge needed for the research topic (SLO 1). 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 and breadth of the knowledge needed in their field (SLO 1).
2. ***Comprehensive Exam***: The comprehensive examination involves examination of the depth and breadth of the specific knowledge in the field of study, and a written proposal describing the research the student will conduct (SLO 3). Through the proposed research, students must establish their clear and unique contributions to their field of study (SLO 1-4).

Criteria for Success (Thresholds for Assessment Methods):
1. ***Comprehensive Exam***: 95% of students who take the Comprehensive Exam, pass on their first try.
2. ***Program of Study***: 100% of students have filed a Program of Study.

Results and Analysis:

Comprehensive Exams

	2017-18	2018-19	2019-20	2020-21	2021-22	**2022-2023**
# Students	15	35	23	15	17	**14**
# Pass on first attempt	14	35	23	15	17	**14**

To evaluate this outcome, the only mechanism currently being used are students' comprehensive exams, and this is still the best source of measuring SLO 1, as it involves the evaluation of a student on their breadth and depth of knowledge.

Use of Results to Improve Outcomes:

No actions were taken during the planning year designed to impact performance, and no new actions are occurring in the next planning year.

SLO2: INDEPENDENT ACADEMIC RESEARCH

Define Outcome:

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

Assessment Methods:

1. ***Program of Study:*** Every PhD student must complete a Program of Study (PoS) prior to completing 15 credit-hours of course work. The PoS is developed under the guidance of the student's Advisory Committee (AC). The courses specified in the PoS ensures the depth of knowledge needed for the research topic (SLO 1). 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 and breadth of the knowledge needed in their field (SLO 1). The depth and knowledge and the ability to conduct independent academic research (SLO 2) through definition of an appropriate research topic for a dissertation (SLO 3) must be demonstrated through the comprehensive examination process.
2. ***Comprehensive Exam:*** The comprehensive examination involves examination of the depth and breadth of the specific knowledge in the field of study, and a written proposal describing the research the student will conduct (SLO 3). Through the proposed research, students must establish their clear and unique contributions to their field of study (SLO 1-4).

Criteria for Success (Thresholds for Assessment Methods):

1. **Comprehensive Exam**: 95% of students who take the Comprehensive Exam, pass on their first try.
2. **Program of Study**: 100% of students have filed a Program of Study.

Results and Analysis:

Comprehensive Exams

	2017-18	2018-19	2019-20	2020-21	2021-22	**2022-2023**
# Students	15	35	23	15	17	**14**
# Pass on first attempt	14	35	23	15	17	**14**

To evaluate this outcome, the only mechanism currently being used are students' comprehensive exams, and this is still the best source of measuring SLO 2, as it involves the evaluation of a student on their ability to do research.

Use of Results to Improve Outcomes:

No actions were taken during the planning year designed to impact performance, and no new actions are occurring in the next planning year.

SLO3: ABILITY TO IDENTIFY AND DEFINE TOPIC

Define Outcome:

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

Assessment Methods:

Comprehensive Exam: The comprehensive examination involves examination of the depth and breadth of the specific knowledge in the field of study (SLO 2), and a written proposal describing the research the student will conduct (SLO 3).

Criteria for Success (Thresholds for Assessment Methods):

Comprehensive Exam: 95% of students who take the Comprehensive Exam, pass on their first try.

Results and Analysis:

Comprehensive Exams

	2017-18	2018-19	2019-20	2020-21	2021-22	**2022-2023**
# Students	15	35	23	15	17	**14**

# Pass on first attempt	14	35	23	15	17	**14**

To evaluate this outcome, the only mechanism currently being used are students' comprehensive exams, and this is still the best source of measuring SLO 3, as it involves the evaluation of a student on their ability to identify and define a research topic.

Use of Results to Improve Outcomes:
No actions were taken during the planning year designed to impact performance, and no new actions are occurring in the next planning year.

SLO4: CONTRIBUTE TO EXISTING KNOWLEDGE IN THE ENGINEERING FIELD

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

Assessment Methods:
Comprehensive Exam: Through the proposed research, students must establish their clear and unique contributions to their field of study (SLO 4).

Criteria for Success (Thresholds for Assessment Methods):
Comprehensive Exam: 95% of students who take the Comprehensive Exam, pass on their first try.

Results and Analysis:

Comprehensive Exams

	2017-18	2018-19	2019-20	2020-21	2021-22	**2022-2023**
# Students	15	35	23	15	17	**14**
# Pass on first attempt	14	35	23	15	17	**14**

To evaluate this outcome, the only mechanism currently being used are students' comprehensive exams, and this is still the best source of measuring SLO 4, as it involves the evaluation of a student on their ability to contribute to existing knowledge.

Use of Results to Improve Outcomes:
No actions were taken during the planning year designed to impact performance, and no new 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:
Grants Awarded: 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. Summary of the number of grants awarded to faculty, and how many students are supported by the funded research.

Criteria for Success (Thresholds for Assessment Methods):
Grants Awarded: 50% of students are supported in some way by externally funded research.

Results and Analysis:
This is a new SLO, so we only started collecting this information with the Fall 2022 semester.

	2022-2023
# Ph.D. Students Funded on External Research Grants	**38**

This represents **32**% of our Ph.D. population (**Fall 2022: 120**). A goal will be to increase this to **50**% of our Ph.D. students being funded on external research grants.

Use of Results to Improve Outcomes:
No actions were taken during the planning year designed to impact performance, and no new actions are occurring in the next planning year.

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 was outlined in the previous sections of this report. As responses to the identified results, changes implemented in **2022-2023**, or planned for **2023-2024**, are as follows.

Collect Post-Graduation Information (PG 2)

Starting in Spring 2023, surveys were sent to all students who defended their dissertation. 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 hope to be able to gather more metrics that show a student's success in the field of academia (professor/researcher).

List of Appendices:
Appendix 1: Curriculum Map, Engineering PhD
Appendix 2: Course Offerings and Frequency
Appendix 3: Oral Defense and Dissertation Assessment Form

Appendix 1: Curriculum Map, Engineering PhD

Engineering PhD

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: 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 2: Course Offerings and Frequency, cont.

Civil and Environment Engineering

Course Number	Course Title	Semester											
		F17	S18	F18	S19	F19	S20	F20	S21	F21	S22	F22	S23
CEE 5130	Matrix and Finite Element Methods		✓		✓		✓		✓		✓		✓
CEE 5170	Introduction to Mechanics of Composites												✓
CEE 5190	Advanced Mechanics of Materials	✓		✓		✓		✓		✓		✓	
CEE 5350	Advanced Structural Design		✓		✓		✓		✓		✓		✓
CEE 5360	Advanced Topics in Structural Concrete Design	✓		✓		✓		✓		✓		✓	
CEE 5380	Bridge Design	✓		✓		✓		✓		✓		✓	
CEE 5410	Solid and Hazardous Waste Management	✓			✓			✓				✓	
CEE 5420	Engineering Hydrology			✓		✓		✓		✓		✓	
CEE 5430	Water and Wastewater Engineering	✓			✓								
CEE 5440	Water Resources Engineering					✓			✓		✓		✓
CEE 5610	Pavement Design	✓	✓	✓	✓					✓			
CEE 5630	Traffic Engineering	✓		✓			✓			✓		✓	
CEE 5640	Highway Engineering		✓						✓		✓		✓
CEE 5660	Transportation Planning	✓		✓		✓		✓		✓		✓	
CEE 5700	Masonry Design		✓		✓		✓		✓		✓		
CEE 5810	Foundation Engineering				✓		✓		✓		✓		✓
CEE 5850	Forensic Engineering		✓										
CEE 5930	Noise Control	✓											
CEE 5990	Special Problems: Intro. to Composite Materials										✓		
CEE 5990	Special Problems: Computational Hydraulics		✓										
CEE 5990	Special Problems: GIS Applications in CEE		✓			✓			✓				
CEE 5990	Special Problems: Chemistry for Environmental Engineers											✓	
CEE 5990	Special Problems: Aggregates and Quarries											✓	
CEE 6040	Intermediate Fluid Mechanics			✓									
CEE/ENGR 6200	Statistical Inference for Engineers									✓		✓	
CEE 6300	Multiscale Analysis of Concrete	✓		✓		✓		✓				✓	
CEE 6350	Finite Element Analysis		✓		✓		✓		✓		✓		✓
CEE 6400	Traffic Simulation											✓	
CEE 6410	Traffic Control Systems										✓		

Appendix 2: Course Offerings and Frequency, cont.

Computer Science

Course (Department, Number, Title)	F17	S18	F18	S19	F19	S20	F20	S21	F21	S22	F22	S23
CSC 5100 Operating Systems		x	x	x	x	x	x	x	x	x	x	x
CSC 5200 Computer Networks	x	x	x	x	x	x	x	x	x	x	x	x
CSC 5240 Artificial Intelligence	x		x		x		x		x		x	
CSC 5400 Analysis of Algorithms			x									
CSC 5585 Software and Systems Security			x		x		x		x		x	
CSC 5770 Distributed & Cloud Computing							x		x		x	
CSC 5220 Data Mining and ML		x		x		x		x		x		x
CSC 5260 Adv Data Science												x
CSC 5320 Computer Architectur		x	x	x	x	x	x	x	x	x	x	x
CSC 5575 Cryptography		x		x		x		x		x		x
CSC 5760 Parallel Programming												
CSC 6400 Adv Analysis of Algs								x		x		x
CSC 6240 Mathematics and Theory of ML			x				x				x	
CSC 6220 Data Mining		x				x				x		
CSC 6230 Machine Learning				x				x				x
CSC 7210 Anomaly and Intrusion Detection Sys							x					
CSC 7240 Intelligent Info System	x				x				x			
CSC 6260 Advanced Topics in Artificial Intelligence									x			
CSC 6570 Cloud Security										x		
CSC 6575 Internet Security	x		x		x		x		x		x	
CSC 6580 Advanced Reverse Engineering			x	x	x	x		x		x		x
CSC 7575 Security Topics in Cyber-Physical Systems		x	x			x		x				x
CSC 6585 Secure Software Development							x				x	
CSC 7570 A.I. Assisted Cyber									x			
CSC 6xxx Social Engineering			x				x		x		x	
CSC 7720 Distributed Operation Systems				x						x		
CSC 6740 Parallel and Distributed Algorithms	x	x		x		x				x		
CSC 6780 Distributed Computing		x					x				x	
CSC 6730 Advanced Networking									x			
CSC 7750 Topics in HPC								x				
CSC 6910 Graduate Seminar	x		x		x	x	x	x	x	x	x	x

Appendix 2: Course Offerings and Frequency, cont.

Electrical and Computer Engineering

Courses	F2018	S2019	F2019	S2020	F2020	S2021	F2021	S2022	F2022	S2023
ECE 5020: Digital Signal Processing		1		1		1		1		1
ECE 5110: Digital Logic Design	1		1		1		1			
ECE 5120: Fundamentals/Comp Design		1		1		1		1		1
ECE 5130: Intro to Digital VLSI	1		1		1		1		1	
ECE 5140: Embedded System Design				1		1		1		1
ECE 5210: Control System Design I	1		1		1		1		1	
ECE 5370: Mechatronics/Intel Machine Eng						1		1		1
ECE 5510: Electromagnetic Fields II	1		1		1		1		1	
ECE 5520: Optoelectronic Eng		1		1		1		1		1
ECE 5610: Power System Analysis	1		1		1		1		1	
ECE 5620: Power Sys Oper & Control		1		1		1		1		1
ECE 5630: Power Electronics	1		1		1		1		1	
ECE 5710: Principles/Telecomm	1		1				1			
ECE 6040: Signal Analysis										1
ECE 6110: Microprocessors Systems					1				1	
ECE 6130: Computer Architecture										1
ECE 6170: High Perf Embedded Sys			1							
ECE 6200: Linear Systems Analysis	1		1		1			1		1
ECE 6230: Linear Multivariable Sys				1						
ECE 6250: Random Signals & Sys	1						1			
ECE 6280: Nonlinear Auto Control									1	
ECE 6510: Electromag Field Theory I				1		1		1		
ECE 6580: Instr/Transducer Tech	1								1	
ECE 6600: Computer Meth/Pwr Sys		1			1					
ECE 6640: Rnwbl Energy/Distr Generation					1				1	
ECE 6650: Design-Control/Power El Sys							1			
ECE 6670: Pwr Flow Cntrl-Mdrn Pwr Sys				1						
ECE 6710: Communications Sys Theory								1		
ECE 6750: Wireless Comm Sys									1	
ECE 6900: Special Problems		1			1	1		1		
ECE 6910: Intro to Grad Research	1		1		1		1		1	
ECE 6980: Directed Study	1	1	1	1	1	1	1	1	1	1
ECE 7110: Advanced Digital Design			1			1				
ECE 7620: Adjustable Speed Drives			1					1		
ECE 7640: Distributed Energy Sys						1				1
ECE 7750: Advanced Wireless Sys	1									

Appendix 2: Course Offerings and Frequency, cont.

Mechanical Engineering

Course	Course Title	F20	S21	F21	S22	F22	S23
ME 5060	Machine Vibrations		X		X		X
ME 5120	Intermediate Dynamics		X		X		X
ME 5140	Introduction to Robotics	X		X		X	
ME 5160	Experimental Stress Analysis						
ME 5180	Finite Element Methods in ME	X		X		X	
ME 5190	Adv. Mechanics of Materials	X		X		X	
ME 5210	Refrigeration & AC	X		X		X	
ME 5220	Air Conditioning Design		X		X		X
ME 5260	Energy Cons. & Conversion	X		X		X	
ME 5310	Gas Dynamics			X			
ME 5370	Mechatronics		X		X		X
ME 5380	Data Acquisition and Signal Proc		X		X		X
ME 5450	Design for Manufacturability		X				X
ME 5460	Mechanical Prop. Of Materials	X		X		X	
ME 5470	Inter. Stud. Ceramic Mat. Proc.						
ME 5480	Microstructural Analysis		X		X		X
ME 5490	Prop. & Sel. Of Engr. Materials						
ME 5510	Aerodynamics		X		X		X
ME 5610	Steam Power Plants		X		X		X
ME 5620	Turbomachinery		X		X		X
ME 5630	Internal Combustion Engines	X		X		X	
ME 5640	Dynamics of Machinery II			X			
ME 5720	Thermal Design	X	X	X	X	X	X
ME 5730	Numerical Heat Transfer	X		X		X	
ME 5810	Modern Controls		X		X		X
ME 5930	Noise Control	X		X		X	
ME 6010	Conduction Heat Transfer	X				X	
ME 6030	Radiation Heat Transfer			X			
ME 6040	Intermediate Fluid Mechanics	X		X		X	
ME 6050	Convection Heat Transfer		X		X		X
ME 6210	Advanced Thermodynamics		X				X
ME 6350	Finite Element Analysis		X		X		X
ME 6360	Introduction to Continuum Mechanics			X			
ME 6370	Vibrations of Continuous Media				X		
ME 6430	Fundamentals of Acoustics						
ME 6440	Applied Acoustics						
ME 6510	Motion Prog. Of Planar Mechanisms						

Appendix 2: Course Offerings and Frequency, cont.
Mechanical Engineering

ME 6610	Advanced Machine Design I						
ME 6620	Advanced Machine Design II						
ME 6640	Advanced Robotics			X			
ME 6710	Advanced Dynamics of Machinery				X		
ME 6730	Modal Vibration Analysis						
ME 6760	Smart Materials and Structures	X					
ME 6810	Advanced Material Science I			X			
ME 6830	Advanced CAD			X			
ME 6910	Intro to Graduate Research	X		X		X	
ME 6930	Theory of Elasticity	X		X		X	
ME 7040	Mass Transfer						
ME 7060	Advanced Numerical Heat Transfer	X				X	
ME 7070	Fluid Mechanics of Suspensions				X		
ME 7080	Advanced Viscous Flow			X			
ME 7090	Computational Fluid Mechanics		X				X
ME 7100	Turbulence			X			
ME 7510	Space Mechanisms		X				X
ME 7600	Plates and Shells		X		X		X
ME 7620	Finite Element Analysis II	X		X		X	
ME 7640	Theory of Inelastic Materials						
ME 7650	Continuum Theories of Materials						
ME 7660	Fracture Mechanics				X		
ME 7670	Composite Materials						
ME 7680	Fiber-Reinforced Composites						
ME 7720	Transfer Function Synthesis						
ME 7810	Advanced Material Science II		X				X

Appendix 3: 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:

Not Acceptable	Below Expectation	Meets Expectation	Above Expectation
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

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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