

Institutional Effectiveness Report 2018-19

Program: Mechanical Engineering MS

College and Department: College of Engineering – Mechanical Engineering

Contact: Mohan Rao

Mission: The Mechanical Engineering (ME) Department, within a regional and global context, will prepare its students for productive career in a competitive, dynamic, technologically-based society; will advance the knowledge of mechanical engineering principles and applications; and will serve the public.

The Mechanical Engineering M.S. program at Tennessee Tech provides students advanced engineering skills and state-of-the-art knowledge in selected areas for positions in industry or pursuing a PhD.

Students focus their programs on specific interests among several areas:

- Acoustics and Vibrations
- Design / Mechanical Systems
- Energy Harvesting / Smart Materials
- Energy Storage / Fuel Cells / Battery
- Smart Materials / Sensors

Program Goals:

1. Recruit and mentor very talented, research active faculty who will excel in teaching, research and scholarly activities and enhance the reputation of the Department of Mechanical Engineering at both regional and national levels.
2. Increase the number and quality of MS and PhD graduates until they are about 10% of the undergraduate population. The goal is to have a thriving graduate program with quality students.
3. Increase externally funded research activation, proposals and journals submitted, and conference publications of the Department of Mechanical Engineering faculty per year.

Student Learning Outcomes:

1. Improve communication skills of Mechanical Engineering graduate students through mastery in both verbal and written communication skills.
2. Demonstrate the ability to conduct basic theoretical and/or applied research (MSME Thesis Option) or Independent study (MSME Non-thesis Option).
3. Students will give professional presentations or write scholarly manuscripts worthy of publication in conferences and/or peer reviewed journals.

A departmentally developed curriculum map can be found in Appendix 1 that shows the connections between courses and student learning outcomes.

Assessment Methods:

1. *Graduate Student Exit Interviews:* Written survey and oral discussion with students are targeted toward determining the quality of the program, attainment of selected learning outcomes, and the adequacy of resources and facilities to achieve these. See Graduate Student Exit Interview Form for the survey questions included. The survey results will be updated in the upcoming year since data are analyzed once every two years.
2. *Percentage of MSME Students Employed or Attending Graduate School in another university:* The ME Department, along with the Centers of Excellence, perform exit interviews with graduating students and collect data on their next placement, feedback to the program, and level of their success. The data is collected, compiled and analyzed by the Centers and departments as a tool to improve the quality and environment of the graduate program. Percentage of MSME students who are employed upon graduation or who have been admitted to PhD programs is a good indicator of the quality of our graduate program. The results will be updated in the upcoming year since data are analyzed once every two years.
3. *Co-Op Employer Surveys:* Administered by the Office of Career Services to employers of students participating in the Co-Op program. Employers provide feedback regarding (1) individual student performance, and (2) more general assessment-related questions regarding performance of the M.E. program. Results are presented when available.

4. *Alumni Surveys:* One way of evaluating the effectiveness of the graduate program is to track the placement and performance of MS graduates either in their places of employment or doctoral programs in which they are enrolled. Results of such surveys help identify any weaknesses in the program for appropriate remedial measures to be crafted and implemented. They also help
5. *ME External Advisory Board Feedback:* Feedback from the ME External Advisory Board is an important source of program improvement, guidance, and supporting evidence regarding the performance of students who are graduates of the MSME program. The Advisory Board contains representatives of several key constituency groups of the program, i.e., employers, alumni, and the professional community at large.
6. *IDEA Teaching Evaluations:* IDEA evaluations are a university required tool for assessment of teaching of graduate faculty. The average IDEA ratings on Progress on Relevant Course Learning Objectives, Teaching Effectiveness, and Usefulness of the Course are used. The IDEA survey instrument makes provision for students to provide comments on each course. Some students use this as a vehicle to provide feedback on course topics and course requirements.
7. *Average Number of Funded Research Projects:* A summary of external funds generated by the M.E. department using data provided by the Office of Research (per year per ME Faculty Member) is an indicator of the growth of external research provided by the faculty. Data are compiled for proposals and activations by the College of Engineering.
8. *Average Journal and Conference Publications per faculty per Year:* All faculty members engage in regular professional development that enhances their teaching, scholarship and practice. These include but are not limited to the participation in workshops, training courses, and conferences, technical paper and proposal reviews, journal and conference publications, conference and symposium organization, and professional society activities. Support for faculty develo Td(S)(h)2.3 (e)7rttnody AMCID

(Dr. Corinne Darvennes). In addition, Dr. Dale Wilson assumed the position as an interim chair of MET. These positions need to be replaced.

Program Goal 2: Increase Number of MS Students per Year

Over the period from 2012-2017, a total of 715 complete student applications to the MSME program were received. Two hundred and eighty-four applications (40%) were granted admission (including provisional standing). A total of 165 actually enrolled during this time. Sixty-one MS degrees have been awarded during this period. These data are a reflection of the high standards related to retention and quality control of MS graduates that is implicit in the MSME program.

During 2018-19, the number of MS and PhD applications to the department was slightly down compared to the previous year, mainly because of reduction in international applications. This is a national trend that is attributed to the political climate and difficulties for many international students in obtaining their visas. Our applications from domestic MS students were very healthy and we have a large number of our own BSME students interested and enrolled in the fast -track MS program.

Program Goal 3: Increase Research and Scholarship Activities

The ME department faculty members engage in regular professional development that enhances their teaching, scholarship and practice. These include but are not limited to the participation in workshops, training courses, and conferences, technical paper and proposal reviews, journal and conference publications, conference and symposium organization, and professional society activities.

More than 120 journal papers and 70 conference proceedings were published by the ME graduate faculty during 2012-2018, translating into an average number of scholarly articles published in journals by the collective ME faculty of approximately 21 journal papers per year. Several of the published papers were lead-authored or co-authored by MS students.

The ME department faculty also engage in externally funded research projects/grants from agencies such as the National Science Foundation, Department of Defense, Department of Energy, Office of Naval Research, NASA, Air Force Office of Scientific Research, ASHRAE, MIT Lincoln Labs, State of TN, and industries such as Cummins and Bristol Compressors, among others. Sponsored projects facilitate research and scholarship, which consequently help build intellectual capital for the MS and Ph.D. programs through student-involved research activity and the possible creation of knowledge in the process. Funds generated from externally sponsored projects and proposals submitted by the ME faculty during the past five years have increased from about \$600k to \$1.7 million.

Student Outcome 1: Communication in Area of Specialization

Graduate students are required to make oral presentations of their thesis. Evaluation feedback for these oral presentations is provided to the students, which helps them to improve their technical communication skills. Many of the core courses also require oral presentations that are evaluated as part of the course grades. Evidence of achievement in technical writing is provided through the accomplishment of written theses that are reviewed and approved by the student's advisory committee.

Oral Defense and Thesis Assessment Results

	Not Acceptable	Below Expectations	Meets Expectations	Above Expectations
Visual Aids	0%	0%	28%	72%
Presenter	0%	0%	17%	83%
Presentation mechanics	0%	0%	43%	57%
Quality of English	0%	0%	4%	96%
Technical Content	0%	0%	22%	78%
Technical Writing	0%	0%	17%	83%

The Graduate Student Exit Interview Survey asks students "Have you attended any professional meeting/conference during your graduate program?". Six of the eight students (75%) who responded indicated having attended a professional meeting/conference. Students are also asked "Have you authored or co-authored a paper during your graduate program?". Six of eight students (75%) who responded indicated having authored or co-authored a paper.

Modifications for Improvement:

SLO2: Faculty are working to propose a change to the Research and Thesis credit requirements so that MS students can get involved in research earlier in the program. The change would go in effect Fall 2019.

Appendices

1. Curriculum Map

Appendix 1: Curriculum Map

Curriculum Map of MS Program in Mechanical Engineering			
	Student Learning Outcomes		
Courses & Degree Requirements ↓	Demonstrate an enhanced expertise in their area of specialization in Mechanical Engineering.	Conduct basic, applied and/or empirical research and/or design.	Give professional presentations or write scholarly manuscripts worthy of publication in conferences and or peer reviewed journals.
Graduate Level Coursework. * (Minimum 21 credit hours for thesis Option; 30 credit hours for non-thesis). A maximum of 9 credit hours can be at the 5000 level.	X		
ME 6990- Research and Thesis (6 to 8 credit hours for thesis option).	X	X	X
ME 6960- Independent Project Course (3 credit hours for non-thesis option).	X	X	X
ME 6910-1 credit. Introduction to Graduate Research		X	X

* Graduate-level courses in the Mechanical Engineering Department have been grouped into four broad categories; refer to Table 1 below. To ensure that students are exposed to a breadth of fundamental engineering principles, it is proposed that students will be required to register for at least two courses listed in each category, courses deemed to be acceptable for potential inclusion in the program of study are listed in bold red font in Table 1. The content and format of the independent project course, including the comprehensive examination, for non-thesis will be entirely at the discretion of the faculty member teaching the class. Typically, this course will be taken in the final semester listed on the program of study. The approved program of study can list no more than two three-credit hour, 6000-level courses in either advanced mathematics or science.

**Suggested Categories of Graduate-Level Courses
Currently Offered in the Mechanical Engineering Department**

Energy, Fluids, and Thermal Systems

ME 5210 Refrigeration and Air Conditioning

ME 5220 Air Conditioning Design

ME 5260 Energy Conversion and Conservation¹

ME 5310 Gas Dynamics

ME 5510 Aerodynamics

ME 5610 Steam Power Plants

ME 5620 Turbomachinery

ME 5630 Internal Combustion Engines

ME 5720 Thermal Design

ME 5730 Numerical Heat Transfer

ME 6010 Conduction Heat Transfer

ME 6030 Radiation Heat Transfer

ME 6040 Intermediate Fluid Mechanics

ME 6050 Convection Heat Transfer

ME 6210 Advanced Thermodynamics

ME 7040 Mass Transfer

ME 7060 Fluid Mechanics II (3.0)

ME 7650/CEE 7650 Continuum Theories of Materials
ME 7660/CEE 7710 Fracture Mechanics
ME 7670/CEE 7720 Fiber-Reinforced Composite Materials
ME 7680/CEE 7820 Theory of Elastic Stability
ME 7810 Advanced Materials Science II