Program Review (12-11-2020)
UW-Green Bay Mechanical Engineering

Submitted by: **RSE Chair Professor Patricia Terry**
terryp@uwgb.edu, 465-2749

The **Mechanical Engineering BS** is part of the **Resch School of Engineering**, housed in the **College of Science, Engineering, and Technology** led by **Dean John Katers**.

UW-Green Bay Mechanical Engineering

General and Overview

1. Describe your program's most significant opportunities and significant challenges. (Narrative)

One of the Mechanical Engineering program's opportunities remains meeting the regional manufacturing community's need for skilled employees. The most significant challenge continues to be resources, specifically faculty. The ME program grew faster than anticipated, requiring more than one section of some classes, which has put a strain on faculty resources. We meet the curricular needs via overloads and ad-hoc instruction. The total growing number of Engineering and Engineering Technology students has also strained Physics and Mathematics faculty resources.

The most significant opportunity is to offer the complete BS on the Sheboygan campus. The challenge is that we need additional faculty dedicated to that campus and we need significant laboratory equipment to offer labs there. There is potential to offer weekend lab days on the Green Bay campus, but that would require faculty resources that we do not currently have and a willingness and ability for Sheboygan students to travel to the Green Bay campus several Saturdays each semester for each lab class in which they enroll.

2. What are some things that would help make your program and its students more successful? (Narrative)

Faculty resources to offer both daytime and face-to-face classes vs evening and on-line classes would benefit some students. The most useful action that would benefit students would be increased tutoring for math, physics, chemistry, and basic engineering classes. Many students come to us under-prepared in basic quantitative skills and additional tutoring would help them. Finally, in many of our labs, we have only one piece of equipment, which limits hands-on lab opportunities or requires faculty to have labs that are not optimally aligned with lecture. Additional equipment would help, however, this equipment is often expensive, so I recognize that this is a luxury we likely cannot afford.

3. What are some program accomplishments worth highlighting? (Narrative)

   The ME program was launched in the fall 2019 semester and the first major will graduate in December 2020. The new STEM building on campus, opened in September 2019, adds five laboratory spaces and a computer lab for primarily MET and ME labs. (The computer lab has software to serve all Engineering Tech and Engineering majors). Contributions from regional industries and partners allowed for the purchase of state-of-the-art lab equipment in fluids, engineering measurements, engineering materials, and controls. We also have 16 scholarships, sponsored by regional industry, to support student success.

4. Have there been any significant changes that have affected your program? (Narrative)

   The MET program was launched with two dedicated faulty. Two additional faculty have been added to support both MET and ME programs. Even though the program is new, some significant curricular changes (discussed below) are in process to go into place fall 2021. These two actions and a lecturer added to support ME on the Sheboygan campus have allowed us to offer some upper level electives that will provide students the ability to increase their skills in specific ME topics.

5. Where do you want your program to be 5 to 7 years from now? (Narrative)

   In five years, we anticipate having 200 Mechanical Engineering majors at UWGB with preliminary discussions of starting a graduate program in ME. We will have our first program graduate in December 2020 and will apply for ABET accreditation in the 2021-2022 academic year with a successful site visit September 2022 and accreditation granted in Spring 2023.

Demand

All data in this area is provided with the materials. (Graduates, majors, minors, etc.) This space is for any commentary you would like to apply to that material. (Narrative)

Internal

1. Program goals (Mission, vision, learning outcomes; present as narrative/lists)

   The **Mechanical Engineering** program has **the Student Learning Outcomes** listed below. These are determined by **ABET**, the accreditation agency for engineering programs. Each of these outcomes is assessed annually in a required upper level course and an annual review of this assessment drives curricular changes in the lower level curriculum.

   Students in the Mechanical Engineering program will successfully demonstrate

1. An ability to identify, formulate, and solve complex engineering problems by applying principals of engineering, science, and mathematics

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

2. Curriculum development: **see discussion below explaining curricular changes**

Current ME curriculum	new ME curriculum
ET 116: Basic Manu. Processes (3)	ENGR 216 Manu. Processes (3 cr)
ENGR 204: Intro. to Programming (2)	ENGR 204 Programming (2 cr)
ET 206: Chemistry for Engineers (5)	ET 206 Chemistry for Engineers (4 cr)
ET 207 Parametric Modeling (3)	ET 207 Parametric Modeling (2 cr)
ENGR 208: Fund. of Electrical Circuits (3)	ENGR 308 Electronics (3 cr)
ENGR 213: Eng. Mechanics I: Statics (3)	ENGR 213 Engineering Mech. I (3 cr)
ENGR 214: Eng. Mechanics II: Dynamics (3)	ENGR 214 Engineering Mech II (3 cr)
ENGR 220: Mechanics of Materials (3)	ENGR 220 Mechanics of Materials (3 cr)
ENGR 221: Mechanics of Materials Lab (1)	ENGR 221 Mech of Materials lab (1 cr)
ET 221: Machine Components (3)	ENGR 420 Machine Component Design (3 cr)
ENGR 301: Engineering Materials (2)	ENGR 201 Engineering Materials (2 cr)
ET 308: Finite Element Analysis (3)	ENGR 408 Finite Element Analysis (3 cr)
ENGR 340: Analysis of Dynamic Systems (3)	ENGR 340 Analysis of Dynamic Sys (3 cr)
ENGR 312: Engineering Measurements (2)	ENGR 312 Engineering Measurements (2 cr)
ENGR 322: Engineering Measurements Lab (1)	ENGR 313 Eng. Measure lab (1 cr)
ENGR 326: Numerical Methods (4)	ENGR 304 Numerical Methods (3 cr)
ENGR 324: Engineering Thermodynamics (3)	ENGR 324 Engineering Thermodynamics (3 cr)
ENGR 336: Fluids (3)	ENGR 336 Fluids (3 cr)
ENGR 337: Fluids Lab (1)	ENGR 337 Fluids lab (1 cr)
ET 360: Project Management (3)	
ENGR 430: Heat Transfer (3)	ENGR 430 Heat Transfer (3 cr)
ENGR 431: Thermal Lab (1)	ENGR 431 Thermal lab (1 cr)
ENGR 460: Senior Design (3)	ENGR 460 Senior Design (3 cr)
Elective: one of	ET 104 AutoCAD (1 cr)
ET 322: Design Problems (3)	**Electives: 3 of**
ET 390: Mechatronics (4)	ET 360 Project Management (3 cr)
ENGR 432: Automatic Controls (4)	ET 390 Mechatronics (3 cr)
	ENGR 422 Machine Comp Design II (3 cr)
	ENGR 409 Advanced FEA (3 cr)
	ET 362 Ind. Quan. Decision Proc. (3 cr)

The ME curriculum is in the process of significant revision. These changes have been proposed by UWGB's ME faculty and reflect their knowledge of what a ME program should be. These changes were approved by the RSE executive committee in early Fall 2020 and are being processed through Courseleaf to be in effect for the Fall 2021 semester. A plan has been made to matriculate existing students through the curriculum. To accommodate more ET/ENGR credits, only one semester of Physics (Phy 202 or 104) is required. PHY 103/201 was previously required, but the content is redundant with ENGR 213 and ENGR 214, so it was eliminated. With a re-alignment of credits for ET 206 and ET 207, the new curriculum reduces the credit hours required for the BS, while increasing ENGR classes. This new curriculum better aligns the level of each course and lets students specialize by selecting from a list of electives.

3. Connections to other programs (Lists, brief narrative if appropriate)

The ME and MET programs are highly connected in course content, the primary difference being that the ME program requires two additional math courses, Multivariate Calculus and Differential Equations, beyond Calc 1 and 2, while the MET program remains more hands-on and applied. The ME curriculum provides a stronger theoretical basis to both prepare student for jobs in industry and graduate school should they wish to pursue a future in research and/or academia. Both curricula were designed with the level of rigor required by the accrediting agency, ABET.

4. Number of courses offered (Overall number provided in materials. Chairs: short commentary if appropriate. Provide a sub-grouping of various modalities by percentage. For example, what percentage of your program is available online, hybrid, etc.?)

The ME degree includes 23 required courses, including 4 labs, and there are another five elective courses from which students select three.

The modality breakdown is:
In person: all classes (100%)
On-line or hybrid: 2 required (ENGR 213 and ENGR 216) and two elective courses (ENGR 362 and ET 360) (17.4%)

In the future, more courses may be offered on-line or hybrid to meet program needs. The rapid move to on-line instruction during Covid has demonstrated that we can teach more on-line than we believed we could. However, in-person instruction is by far the best mode for labs and highly quantitative classes.

5. Diversity of students, faculty, and curriculum (Overall number provided in materials. Chairs: short commentary if appropriate; provide examples from curriculum if appropriate.)

Mechanical Engineering and Mechanical Engineering Technology have five faculty members, one tenured, three tenure track, and one lecturer: Jagadeep Thota (associate), Md Riaz Ahmed (assistant), Md Rasedul Islam (assistant), Jian Zhang (assistant), and Nabila Rubaiya (lecturer). While this is too small a number to be statistically significant, we can say that 1/5 of the faculty is female and all represent a non-Caucasian ethnicity (south Asia or Asia).

Mechanical Engineering started in fall 2019, so there are no graduates yet. Diversity of majors for the 2020-2021 academic year are given in Table 1 below. Not surprisingly for engineering, most identified as male. When the ME program started, a number of students transitioned from the Mech ET program and there have also been a few transfer students from regional technical colleges and other universities. This is reflected in the number of students that are older than the traditional high school graduate.

Table 1: Diversity of Mech Eng majors 2020-2021

N=142 majors	number	percent
Gender Identity Male Female	 123 19	 86.6 13.4
First generation college graduate	64	45.1
Age range 19 and under 20-24 25 and older	 44 62 36	 31.0 43.7 25.3

6. Gen Ed, FYS/GPS, CCIHS (Lists)

   WE: ENGR 213, ET 360, ET 400, and ENGR 460
   FYS/GPS: ENGR 198 (not required)
   Capstone: ENGR 460
   Natural Sciences: ET 206 Chemistry for Engineers
   Sustainability: ENGR 202 Intro to Smart Cities
   Humanities: ENGR 260 Intro to Engineering Ethics

   CCIHS: ET 105, ET 220, ET 207

7. Program support and staffing (Chairs: History, trends, and future needs. Depending on program, could be connected to accreditation.)

   As stated above, the Mech ET and ME programs are staffed by five full time positions, with additional needs being met by three ad-hoc instructors (Scott Guttschow, Nic Zeitler, and Wes Schroeder) and two UWGB faculty from NAS (Mike McIntire, Mandeep Bakshi). The full time lecturer is specific to the Sheboygan campus and the program has been approved to hire a tenure track faculty to support ME on the Sheboygan campus.

The RSE budgetary chair and the Engineering discipline chair have been the same person, Patricia Terry, since RSE split from NAS. This fall, Jagadeep Thota was elected to a three-year term as Engineering discipline chair (2020-2023) and Patricia Terry was re-elected RSE Budgetary chair through August 2024.

Program support is provided by two program assistants shared between Human Biology, NAS and RSE, although one of these primarily serves NAS and Human Biology. Additional support for RSE comes from the program assistant in the dean's office.

8. Cost per credit hour (TBD)

All Engineering and Engineering Technology declared majors pay a differential tuition of $700 per semester for those within the plateau (12-18 credits). Those taking fewer than 12 credit hours, pay an additional 58.33 per credit hour. This differential tuition applies to all credit hours, not just ET or ENGR ones, and students are required to declare their major prior to registering for the spring semester of their freshman year. If they wish to apply for ET or ENGR scholarships, they must declare the major in their first semester at UW-Green Bay (freshman or transfer students). The Engineering and Engineering Technology programs rely on this tuition revenue to cover faculty and equipment costs.

External

1. Outreach: student/faculty partnerships, collaborations, participation with organizations or individually (Lists)

The Engineering/ET programs have an advisory board that includes over forty organizations, who may participate in one or multiple disciplines. The Mechanical ET program advisory board includes organizations such as NWTC, FVTC, Georgia-Pacific, NEW ERA, Paper Converting Machine Corporation, Pioneer Metal Finishing, MCL Industries, GB Decking, Einstein Project, in addition to Ashwaubenon, Howard-Suamico, Green Bay, and Pulaski Public School Districts.

2. Contributions to regional infrastructure (Lists)

UWGB Mechanical Engineering faculty sit on advisory boards for NTWC's Mechanical Design Technology and Manufacturing Engineering Technology Associate's programs and engineering faculty also serve on the NEW ERA advisory board and the NEW Manufacturing board.

3. Scholarly activity of faculty (Lists that are not all-inclusive; maybe seek to highlight the different areas/types of activity)

Jagadeep Thota: experimental and computational solid mechanics, material characterization

Thota J, Trabia MB, O'Toole BJ (2019) *Computational prediction of the damage to a military vehicle composite armor due to ballistic impact*. ASME International Mechanical Engineering Congress and Exposition (ASME IMECE).

Nasif AO, **Mahfuz MU**, **Thota J** (2017) *Noise modeling of nanomechanical communication systems*. 17th IEEE International Conference on Nanotechnology (IEEE-NANO): pp. 49-52.

Nasif AO, **Mahfuz MU**, **Thota J** (2017) *A framework of nanomechanical communication systems based on state transitions*. 10th EAI International Conference on Bio-inspired Information and Communications Technologies (BICT): pp. 106-109.

Computational prediction of the damage to a military vehicle composite armor due to ballistic impact. ASME International Mechanical Engineering Congress and Exposition (ASME IMECE), Salt Lake City, UT. November 11-14, 2019.

Riaz Ahmed: Energy harvesting and bio-inspired mechanical cochlea

Indaleeb, M. M., Banerjee, S., Ahmed, H., Saadatzi, M., & **Ahmed, R.** (2019). Deaf band based engineered Dirac cone in a periodic acoustic metamaterial: A numerical and experimental study. *Physical Review B*, *99*(2), 024311.

Ahmed, H., **Ahmed, R.**, Indaleeb, M. M., & Banerjee, S. (2018). Multifunction acoustic modulation by a multi-mode acoustic metamaterial architecture. *Journal of Physics Communications*, *2*(11), 115001.

Mir, F., Saadatzi, M., **Ahmed, R. U.**, & Banerjee, S. (2018). Acoustoelastic MetaWall noise barriers for industrial application with simultaneous energy harvesting capability. *Applied Acoustics*, *139*, 282-292.

Ahmed, R., & Banerjee, S. (2018). An articulated predictive model for fluid-free artificial basilar membrane as broadband frequency sensor. *Mechanical Systems and Signal Processing*, *100*, 766-781.

***Jian Zhang**: Energy systems and storage*

Xu Ping, Fubin Yang, Hongguang Zhang, Wujie Zhang, **Jian Zhang**, Gege Song, Chongyao Wang, Baofeng Yao, Yuting We, 2020 "Prediction and optimization of power output of single screw expander in organic Rankine cycle (ORC) for diesel engine waste heat recovery", Applied Thermal Engineering, Accepted.

Rebecca Neves, **Jian Zhang**, and Heejin Cho, 2020 "Techno-Economic Analysis of Geothermal System in Residential Building in Memphis, TN", Journal of Building Engineering, 27, 100993.

Jian Zhang, Heejin Cho, Pedro J. Mago, Hongguang Zhang, and Fubin Yang, 2019, "Multi-objective Design Optimization for Distributed Energy Systems with Energy Storage," Journal of Thermal Science, 6, 1221-1235.

Jian Zhang, Heejin Cho, Hongguang Zhang, Fubin Yang, 2018, "Multi-objective Design Optimization for Distributed Energy Systems with Energy Storage: A Case Study", ASME 2018 12th International Conference on Energy Sustainability, June 24-28, 2018, Lake Buena Vista, FL, U.S.

Patents:

Number: ZL201510036787.1: Regenerative organic Rankine cycle system and its control method for engine waste heat recovery

Number: ZL201220551509.1: A lubricating system for a power machinery

Number: ZL201210350995.5: Lubricating system and control method for single screw expander

Number: ZL201120397965.0: Waste heat recovery system for internal combustion engine based on organic Rankine cycle

Rasedul Islam: Bio-medical engineering, robotics, and control

Islam MR, Brahimi B, Ahmed T, Assad-Uz-Zaman M, Rahman MH (2020) "Chapter 9 - Exoskeletons in upper limb rehabilitation: A review to find key challenges to improve functionality". In: BOUBAKER, O. (ed.) Control Theory in Biomedical Engineering. Academic Press, Elsevier June 2020.

Islam, M.R., Assad-Uz-Zaman, M., Al Zubayer Swapnil, A. *et al.* An ergonomic shoulder for robot-aided rehabilitation with hybrid control. *Microsyst Technol* (2020).

Islam, M. R., Rahman, Mehrani., & Rahman, M.H. (2020) "A Novel Exoskeleton with Fractional Sliding Mode Control for Upper Limb Rehabilitation" Robotica, Cambridge University press.

Islam, M. R., Assad-Uz-Zaman, M. & Rahman, M.H. (2020) "Design and Control of an Ergonomic Robotic shoulder for Wearable exoskeleton robot for Rehabilitation" Int. J. Dynam. Control, Vol:8, Issue:1, Page 312–325.

Assad Uz Zaman, M., **Islam, M.R**., & Rahman, M.H. et al. (2020), "Robot sensor system for supervised rehabilitation with real-time feedback". Multimedia Tools Appl 79, 26643–2660

Student Success

1. High-impact practices and individualized-learning opportunities (Some data provided; lists and/or brief narrative)

All Mechanical Engineering students are required to complete a capstone, senior design high impact experience in which they work in small groups to apply their complete knowledge to a specific design project. This class will run for the first time this spring and preliminary talks with Infinity Machine, a DePere based company, have been held to arrange a meaningful industry project for the students to complete. Students may also complete an internship with an appropriate company or industry. In the past year, Mechanical Engineering students have worked for companies such as Duracell and Superior Diesel. Students may also engage in undergraduate research with one of our four faculty in mechanical Engineering.. Students also complete a number of classes with a lab component, including Mechanics of Materials, Engineering Measurements, Fluids, and Heat Transfer, where they learn to use and apply the modern tools of engineering design and measurement.

UW-Green Bay has an active Engineering club that schedules industry tours and invites guest speakers from industry and professional organizations, such as the American Society for Mechanical Engineers and the Wisconsin Society of Professional Engineers to visit and discuss their companies. Engineering students may also participate in UWGB's Rocketry club to design, build, and launch rockets.

2. Retention (TBD. Note: if program-level data is not provided, maybe list some things your program does that you believe aid in retention.)

The Mechanical program achieves high retention rates by keeping class sizes under roughly 30-40 students (although this is changing), providing state-of-the-art lab experiences, offering individualized advising, and very high quality instruction (I can offer the course evaluations of any of my faculty to demonstrate their excellence).

Mission Relevant

1. Relevance to mission (Narrative or lists as appropriate)

For the **UW-Green Bay select mission**, the **Program Educational Objectives** (PEOs), listed in this document under program goals, align well with, "provides a problem focused educational experience that promotes critical thinking and student success." PEO 1 reflects promoting student success because securing and maintaining employment in the field of study after graduating is a clear measure of success and PEO 3 states that students will achieve positions of increased responsibility, which also comes from success in the workplace. PEOs 2 and 4 specifically speak to a "problem focused education" and "promotes critical thinking." The nature of the engineering technology degree is to be hands-on, applied, and problem focused. "The culture and vision of the University reflect a deep commitment to diversity and inclusion," is met by PEO

4, which emphasizes appreciation for diversity and teamwork. Ethical behavior also supports inclusivity. “Community based partnerships” are one foundation of UW-Green Bay’s engineering programs and this is reflected in PEO 1, maintaining employment, and PEO 3, membership in professional societies. The “commitment to educational opportunity at all levels” is supported by PEO 3’s goal that graduates will exhibit a desire for life-long learning. The mission states a commitment to a University that promotes access, career success, cross discipline collaboration, cultural enrichment, economic development, entrepreneurship, and environmental sustainability is included in all four PEOs. PEO 1 supports the economic development of the northeast Wisconsin region, which is the industrial base of the state of Wisconsin. The need for graduates with engineering degrees is very high and supplying these is critical to the state’s economic future. PEO 2 speaks to entrepreneurship because solutions to modern day problems rely on novel, cross discipline approaches. PEOs 3 and 4 address career success directly through “positions of greater responsibility” and “leadership” and indirectly through “high levels of oral and written communication skills, responsibility and ethical behavior, teamwork and appreciation for diversity” because career success requires all of these skills.

2. Cultural enrichment (Narrative or lists as appropriate)

   Engineering/Engineering Technology does not directly provide cultural enrichment, but this discipline has a diverse faculty that includes three female faculty (including the Budgetary chair) to help promote inclusion and cultural diversity by example.

3. Access (Does the program have any agreements with other institutions? For example, a transfer agreement with a technical college.)

   We do not have articulated transfer agreements with any technical colleges, but there is a list of individual courses that can be completed at NWTC, FVTC, LTC, MPTC.