Michigan Tech

Office Memo

Office of the Provost and
Senior Vice President for Academic Affairs

Phone: (906) 487-2440
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TO: Richard Koubek, President

FROM: Andrew Storer, Provost & Senior Vice President for Academic Affairs

DATE: March 18, 2025

SUBJECT: Senate Proposal 15-25

Attached is Senate proposal 15-25, “Establishment of a Bachelors of Science in Aerospace Engineering, Concentration: Engineering Enterprise,” and a memo stating the Senate passed this proposal at their March 13, 2025 meeting. I have reviewed this memo and recommend approving the proposal.

If you concur with my recommendation, advertising the new concentration can begin since approvals from the Board, MASU, and in this case HLC are not required.

I concur X do not concur _____ with the provost’s recommendation as stated in this memo.

Richard J. Koubek Digitally signed by Richard J. Koubek
Date: 2025.03.19 11:52:09 -04'00'

Richard Koubek, President

Date

University Senate

Michigan Tech

DATE:	March 13, 2025
TO:	Richard Koubek, President
FROM:	Robert Hutchinson, University Senate President
SUBJECT:	Proposal 15-25
COPIES:	Andrew Storer, Provost & Senior VP for Academic Affairs

At its meeting on March 13, 2025, the University Senate approved Proposal 15-25, "Establishment of a Bachelors of Science in Aerospace Engineering, Concentration: Engineering Enterprise." Feel free to contact me if you have any questions.

The University Senate of Michigan Technological University
Proposal 15-25

Establishment of a Bachelors of Science in Aerospace Engineering, Concentration: Engineering Enterprise

Submitted by:
Department of Mechanical and Aerospace Engineering

1. Basic Program Information

Primary Contact: Jason Blough, Chair
Department of Mechanical and Aerospace Engineering

Program/Degree Type: BS

Program Title: Bachelors of Science in Aerospace Engineering, Concentration: Engineering Enterprise

Planned Implementation Date: Fall 2025

Program location/modality: on campus / face-to-face

Target Student Population: New students; anticipate transfer requests from BSME students

General Description and Characteristics of the Program:

The Bachelors of Science in Aerospace Engineering (BSAE) will prepare students for professional practice in aeronautical and astronautical industries. The BSAE four-year curriculum tightly integrates mechanical engineering science and practice with the theory and practice of aerospace engineering. The curriculum follows the signature hands-on education for which Michigan Tech is known. The addition of this program fills a gap in Michigan Tech's engineering offerings.

The curriculum covers aeronautical and astronautical aspects of aerospace engineering, with an in-depth coverage of space systems and spacecraft engineering. Graduates of the BSAE program have the opportunity to become leaders in the aeronautics industry as well as the rapidly growing space systems sector and the national/international initiatives in planetary exploration. The BSAE program is designed to also provide the stimulus and preparation for students to be successful in pursuit of graduate studies in aerospace engineering.

The BSAE program was approved by the University Senate and Administration (see Senate Proposal 17-24) with state approval in October 2024 and an official start in the 2025-2026 academic year. The Enterprise Concentration proposed here is a project-intensive curriculum path for students pursuing the BSAE degree.

Rationale:

National and state demand for aerospace engineers

The U.S. Bureau of Labor Statistics, in 2022, projects a 6% growth in aerospace engineering jobs (approximately 3900 new jobs per year) through 2032.[1] This growth is also true for Michigan even though it is not widely recognized as having a significant aerospace industry. Michigan Tech is a member of the Aerospace Industry Association of Michigan (AIAM)[2], which has over 900 member companies. The Michigan Aerospace Manufacturers Association (MAMA)[3] is made up of over 200 manufacturing

[1] https://www.bls.gov/ooh/architecture-and-engineering/aerospace-engineers.htm
[2] https://aiamnow.com/
[3] https://www.michman.org/about/#

companies that focus on aerospace. AIAM and the MAMA reinforce the national and state level need for aerospace engineers.

Interest from students

Currently, Michigan Tech offers a minor in Aerospace Engineering through the Mechanical Engineering Department. Over the last 5 years, 182 students have earned the Aerospace Minor (approximately 13% of all BSME graduates). Two of the major enterprises on campus are directly related to the aerospace industry. The Aerospace Enterprise has 67 students this fall. The Multiplanetary INnovation Enterprise (MINE) has 75 students in Fall 2023 and projects 90 to 100 students enrolled in Spring 2024. A new aerospace-related enterprise, Aeronautics and Rocketry (AER), started in Fall 2024 semester and currently has over 40 students. In 2022, Michigan Tech established a student chapter of the American Institute of Aeronautics and Astronautics (AIAA). This student organization has over 173 students who indicate interest in participating, with 80 members currently registered with Involvement Link.

There is strong interest by prospective students in pursuing Aerospace Engineering. Admissions completed a study in May 2023 on the potential for Aerospace Engineering to increase undergraduate enrollment at Michigan Tech. Some key points from this study are:

- In speaking with our regional team, the most asked about majors that we don't offer are Aerospace Engineering and Nursing
- While students understand that we do offer a lot of opportunities in aerospace, some choose to go elsewhere because we simply do not offer a degree in aerospace
    - Choosing a degree based on minors, research, and enterprise programs is only supportive to an aerospace degree in their mind
- Aerospace Engineering, except for a small median percent decrease in 2017, is the only engineering discipline to show an increase [in enrollment] from 2018 to 2020

The ASEE 2020 Engineering and Engineering Technology By the Numbers reports that "all institutions reported a median percent decrease in freshmen engineering enrollment in Fall" except Aerospace Engineering, which is the only engineering degree with a sustained growth in first year enrollment. Table 4 from that report is included here for reference.

Table 4: Year-to-Year Median Percent Change in Freshmen Enrollment by Engineering Discipline.

Discipline	2017	2018	2019	2020	# Institutions
Aerospace Eng.	-1.5	1.4	8.5	5.0	37
Architectural Eng.	6.5	-4.4	4.1	-18.2	12
Biological Engr. And Agricultural Engr.	-8.5	12.3	-11.8	-6.3	21
Biomedical Eng.	4.3	-4.5	-1.6	-10.2	86
Chemical Eng.	5.6	-5.3	-1.0	-10.4	96
Civil or Environmental Eng.	0.0	0.0	-3.0	-3.6	167
Computer Science (inside engineering)	-7.7	6.9	2.0	-2.2	115
Computer Science (outside engineering)	-5.0	7.3	7.0	6.4	29
Electrical or Computer Eng.	0.0	0.0	-5.6	-9.8	269
Eng. (General)	8.3	-4.7	-7.4	0.0	39
Eng. Management	8.6	-9.2	0.0	0.2	8
Engr. Science and Engr. Physics	0.0	0.0	25.0	-16.7	19
Industrial/Manufacturing/Systems Eng.	0.0	0.0	-5.2	-14.3	63
Mechanical Eng.	1.3	-1.2	-1.3	-5.0	174
Metallurgical and Matrls. Eng.	-8.7	7.7	-3.9	-8.8	32
Mining Eng.	56.3	-23.4	-8.3	-3.8	4
Nuclear Eng.	13.9	-13.6	33.3	-25.0	9
Petroleum Eng.	-3.3	6.0	-3.6	-11.2	10

Current faculty interest

Michigan Tech is well-positioned to quickly implement a BSAE program. Currently, 26% of MAE faculty have aerospace degrees and/or significant aerospace background. MAE currently offers eight technical electives directly related to aerospace alone, and those courses support the aerospace minor. The Michigan Tech Aerospace Engineering Research Center (MARC) had $3,846,899 total awarded dollars for aerospace-specific projects from July 1, 2022 to June 30, 2023.[4]

Related Programs (within MTU and at other institutions):

A Bachelor of Science in Aerospace Engineering was approved by the University Senate and Administration in August 2024 (see Senate Proposal 17-24).

Projected Enrollment:

The long-term projected enrollment in the BSAE program is anticipated to be between 400 and 600 students with 100 to 150 students starting each year. This projection is based on the number of current students actively engaged in aerospace studies and national enrollment in BSAE programs as compared to mechanical engineering.

From the 2020 ASEE report (the latest available) the ratio of mechanical engineering students to aerospace engineering students is a factor of 7.6 for BS degrees awarded and 5.4 for enrollment. If we are on the national average with a projected enrollment next year of 1250 BSME students (based on current graduating seniors and a similar first-year enrollment next year) we could expect a steady-state enrollment between 160 and 240 aerospace students based solely on national averages. That said, enrollment in aerospace programs nationally is skewed with a few large programs. The top 20 programs graduate more than 100 students per year. We anticipate moving quickly into the top 20 in BSAE degrees awarded annually (as we have been historically in BSME) , which based on the 2020 ASEE report would be between 100 and 150 BS degrees annually – hence the 400 to 600 enrollment projection. This projected growth is also based on (i) our strong reputation for engineering, (ii) strong student interest in aerospace and space systems, and (iii) there are only four aerospace programs regionally, two in Michigan (UM, Western), none in Wisconsin, and two in Minnesota (UMN, St Cloud).

There were 142 students enrolled in the two-aerospace enterprises during the Spring 2024 semester. Historically, 30% to 40% of BSME students opt for the BSME Enterprise Concentration. We anticipate a higher percentage of BSAE students opting for the BSAE concentration. We do not anticipate that the Engineering Enterprise Concentration will further increase BSAE enrollment beyond the 400 to 600 projection.

Specialized Accreditation Requirements:

The BSAE program would be accredited through ABET. Performance indicators and assessment instruments will be developed for each of the ABET Student Outcomes (listed in section 2).

Professional Licensure Requirements:

not applicable

2. Curriculum Details

Learning Goals:

Student Outcomes associated with the program are: (ABET EAC Criterion 3)

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

[4] December 12, 2023 TechTracS report from MTU Sponsored Operations Office

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 judgments, 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 judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The degree program must also fulfill the ABET Program Specific Requirements, which are provided below. The program criteria will drive curriculum content and learning experiences and faculty qualifications.

Lead Society: American Institute of Aeronautics and Astronautics

These program criteria apply to engineering programs that include "aerospace," "aeronautical," "astronautical," or similar modifiers in their titles.

1. Curriculum

Aeronautical engineering or similarly named engineering programs must include the following curricular topics in sufficient depth for engineering practice: aerodynamics, aerospace materials, structures, propulsion, flight mechanics, and stability and control.

Astronautical engineering or similarly named engineering programs must include the following curricular topics in sufficient depth for engineering practice: orbital mechanics, space environment, attitude determination and control, telecommunications, space structures, and rocket propulsion.

Aerospace engineering programs or similarly named engineering programs, which combine aeronautical engineering and astronautical engineering topics, must include all curricular topics in sufficient depth for engineering practice in one of the areas—aeronautical engineering or astronautical engineering as described above—and, in addition, similar depth in at least two topics from the other area.

The major design experience must include topics appropriate to the program name.

2. Faculty

The program must demonstrate that faculty members teaching upper-division courses have an understanding of current professional practice in the aerospace industry.

Assessment Plan:

The assessment plan and process will be the same as currently used in the BSAE program. A curriculum committee made up of elected faculty representatives review course and program changes. An assessment committee collects assessment with cooperation of the curriculum committee and course coordinators, then reviews that data and makes recommendations to the faculty as part of the program's continuous improvement process.

Curriculum Design:

Total Credits: 128

BSAE Curriculum Design:

Required Courses (104 cr): [AE prefix denotes a new aerospace course]

Math and Science (31 cr)
- CH1150/1151 Chemistry I + Lab
- PH2100/1100 Physics I + Lab
- PH2200/1200 Physics II + Lab
- MA1160 Calculus I w/ Technology
- MA2160 Calculus II w/ Technology
- MA3160 Calculus III + Technology
- MA2320 Linear Algebra
- MA3520 Differential Equations
- MA3710 Statistics

Engineering (73 cr)
- ENG 1101 Engineering Analysis and Problem Solving
- ENG1102 Engineering Modeling and Design
- ME2110 Statics
- ME2150 Mechanics of Materials
- ME2201 Introductory Thermodynamics
- ME2700 Dynamics
- AE2500 Principles of Aerospace Engineering
- AE2550 Space Environment & Operations
- ME2901 ME Practice 1
- ME2911 ME Practice 2
- ME3750 Dynamic Systems
- AE3501 Aerospace Systems Engineering Practice
- AE3511 Spacecraft Engineering Practice
- AE3520 Aerodynamics
- AE4530 Compressible Flow
- AE4570 Space Mechanics
- AE4540 Aerospace Propulsion
- AE4550 Spacecraft Thermal Control
- AE4550 Aerospace Materials & Structures
- AE4570 Spacecraft Dynamics and Control
- ENT3950 Enterprise Project Work III
- ENT3960 Enterprise Project Work IV
- ENT39xx Enterprise Module
- ENG4950 Enterprise Project Work V Capstone
- ENG4960 Enterprise Project Work VI Capstone
- 3 credits of Technical Electives

Essential Education (37 cr requirement, 24 credits not met by major) :
- Michigan Tech Seminar (1 cr): met through ENG 1101
- Composition
- Foundations of the Human World
- Math: met through Math/Science list
- Natural and Physical Science: met through Math/Science list
- STEM: met through Math/Science list
- Distribution Pathway
  - Communications Intensive
  - Arts and Culture
  - Intercultural Competency
  - SHAPE elective
  - STEM: met through Math/Science list

Essential Education Experience
Activities for Well-Being and Success (minimum 3 courses / 3 credits total)

The BSAE, Concentration: Engineering Enterprise program has 3 less credits of technical elective and 3 additional credits of enterprise content as compared to the BSAE program. Students may use ENT4950 and ENT4960 as a substitution for ME4910 and ME4911 Senior Design; subject to departmental constraints. The BSAE Enterprise Concentration mirrors the existing BSME Enterprise Concentration.

The minimum Enterprise team participation for MAE students completing the BSAE Enterprise Concentration is four project semesters (ENT3950/3960/4950/4960) with the same Enterprise team. The four semesters do not need to be completed in consecutive semesters. Required Enterprise courses are:

- ENT 39xx Enterprise Module – 1 credit
  - Specific modules may be restricted by class standing, may require instructor approval for registration, may have prerequisites, and/or may be offered in only one semester per academic year or not at all.
  - A total of 1 credit of UN3002 and/or UN3003 (co-op credits) may be used as the Enterprise module for BSAE majors.
- ENT 3950 – Project work – 1 credit. Intended for first semester of the third year and/or when a student has four semesters remaining until graduation. Student may be required to meet team-specific criteria prior to enrollment.
- ENT 3960 – Project work – 1 credit. To be taken after ENT 3950 during the second semester of third year and/or with three semesters remaining until graduation. Student may be required to meet team-specific criteria prior to enrollment.
- ENT 4950 – Capstone Project work – 2 credits. Students must satisfy senior design prerequisite requirements.
- ENT 4960 – Capstone Project work – 2 credits. Student may be required to meet team-specific criteria prior to enrollment.

Total Credits: 128 (same as BSAE program)

BSAE, Concentration: Engineering Enterprise

The new Aerospace Engineering (AE) course descriptions are identical to the BSAE program approved by the university in August 2024 (proposal 17-24), but the numbering scheme has changed slightly in this proposal to match what is being submitted through the 2024 binder process. The AE course number scheme is AE #5##:

1st digit: 2, 3, 4 program year (sophomore, junior, senior)
2nd digit: 5 aerospace (1, 2, 4, 6, 7, 9 used for topical areas of ME courses)
3rd digit: 0, 1 – interdisciplinary & design
2, 3, 4 – aeronautics related
5, 6, 7, 8 – space related
9 – reserved for future use
4th digit: incremental numbering

BSAE Concentration: Engineering Enterprise semester-by-semester plan

Red highlighted courses are specific to BSAE Enterprise Concentration
Essential Education courses in blue text

Semester	Course	Credits	Pre-reqs	Concurrent Pre-reqs	Co-reqs
1-Fall	CH1150/1151 University Chemistry I + Lab	4			
	PH1100 Physics I Lab	1		MA1160	
	MA1160 Calculus I w/ Technology	4			
	ENG1101 Engineering I	3		MA1160	
	Activities for Well-being and Success	1			
	Composition / Read Write Engage	3			
	Total Credits	16			
2-Spring	PH2100 Physics I	3	MA1160	PH1100	
	PH1200 Physics II Lab	1			
	MA2160 Calculus II w/ Technology	4	MA1160		
	MA2320 Linear Algebra	2	MA1160		
	ENG1102 Engineering II	3	ENG1101	MA1160	
	Foundations of the Human World	3			
	Total Credits	16			

Semester	Course	Credits	Pre-reqs	Concurrent Pre-reqs	Co-reqs
3- Fall	PH2200 Physics II	3	PH1100 PH2100 MA2160	PH1200	
	MA3160 Calculus III + Technology	4	MA2160		
	ME2110 Statics	3	MA2160		
	ME2901 Engineering Practice 1	2	ENG1102 UN1015	ME2110	
	AE2500 Principles of Aerospace Engineering	3	ENG1102		
	Communications Intensive	3			
	Total Credits	18			
4-Spring	ME2150 Mechanics of Materials	3	ME2110		
	ME2201 Introductory Thermodynamics	3	CH1150 CH1151 MA2160		
	ME2911 Engineering Practice 2	3	ME2110 ME2901	ME2201	
	ME2700 Dynamics	3	PH2100 ME2110		
	AE2550 Space Environment & Operations	3	ENG1102 PH 2200		
	Intercultural Competency	3			
	Total Credits	18			

Semester	Course	Credits	Pre-reqs	Concurrent Pre-reqs	Co-reqs
5-Fall	MA3520 Differential Equations	2	MA2320 MA2160		
	AE3501 Aerospace Systems Engineering Practice	4	ME2150 ME2700 AE2500 AE2550	ME2911	
	AE3520 Aerodynamics + Lab	3+1	MA3160 ME2201 ME2911 AE2500		
	ENT3950 Enterprise Project Work III	1			
	Arts and Culture	3			
	SHAPE Elective	3			
	Total Credits	17			
6-Spring	MA3710 Statistics	3	MA2160		
	ME3750 Dynamic Systems	4	MA3520 ME2700		
	AE3511 Spacecraft Engineering Practice	3	AE3501		
	AE4530 Compressible Flow	3	AE3520		
	ENT3960 Enterprise Project Work IV	1			
	Essential Education Experience	3			
	Total Credits	17			

Semester	Course	Credits	Pre-reqs	Concurrent Pre-reqs	Co-reqs
7- Fall	ENT4950 Enterprise Project Work V Capstone	2	ME3750 AE3511	MA3710 AE4550 AE4560	
	AE4550 Spacecraft Thermal Control	3	AE3511 AE3520		
	AE4560 Aerospace Materials & Structures	3	ME2150 AE2550		
	AE4570 Space Mechanics	3	ME2700		
	Technical Elective	3			
	Total Credits	14			
8-Spring	ENT4960 Enterprise Project Work VI Capstone	2	ME4901 MA3710		
	AE4540 Aerospace Propulsion + Lab	3+1	AE3520	AE4530	
	AE4580 Spacecraft Dynamics & Control	3	ME3750	AE4570	
	ENT 39xx Enterprise Module	1			
	Activities for Well-Being and Success	1			
	Activities for Well-Being and Success	1			
	Total Credits	12			

New Course Descriptions:

None, all of the Aerospace Engineering courses have been approved.

Program-specific policies, regulations, and rules:

The BSAE program will utilize the existing BSME policies; notably, a "C" or better in MA2160 Calculus II in order to enroll in ME2110 Statics and MEEM2201 Thermodynamics.

The BSAE program will have an Enterprise Concentration option similar to the BSME program. The BSAE Enterprise Concentration would require an enterprise module (1 cr), ENG 3950 (1 cr), and ENG3960 (1 cr) with the ENT4950/4960 substitution for ME4901/4911 Senior Capstone Design. The enterprise substitution for senior design will be subject to the same review as the current BSME process.

Faculty Qualifications:

Current MEEM faculty bios can be found on the department website.

1. Resources needed to support new program

None beyond what has already been approved for the Aerospace Engineering degree.

Program Costs:

None beyond what has already been approved for the Aerospace Engineering degree.