SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

New Baccalaureate Degree Minor

UNIVERSITY:	**SDSU**
TITLE OF PROPOSED MINOR:	**Aerospace Engineering**
DEGREE(S) IN WHICH MINOR MAY BE EARNED:	**Mechanical Engineering, Civil Engineering, Agricultural & Biosystems Engineering**
EXISTING RELATED MAJORS OR MINORS:	**Aerospace Studies, Agricultural & Biosystems Engineering (B.S.), Mechanical Engineering (B.S.), Civil Engineering (B.S.)**
INTENDED DATE OF IMPLEMENTATION:	**2021-2022 Academic Year**
PROPOSED CIP CODE:	**14.0201**
UNIVERSITY DEPARTMENT:	**Mechanical Engineering**
BANNER DEPARTMENT CODE:	**SMEC**
UNIVERSITY DIVISION:	**Jerome J. Lohr College of Engineering**
BANNER DIVISION CODE:	**3E**

☒ **Please check this box to confirm that:**

- The individual preparing this request has read AAC Guideline 2.8, which pertains to new baccalaureate degree minor requests, and that this request meets the requirements outlined in the guidelines.
- This request will not be posted to the university website for review of the Academic Affairs Committee until it is approved by the Executive Director and Chief Academic Officer.

University Approval

To the Board of Regents and the Executive Director: I certify that I have read this proposal, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.

Barry H Dunn — 3/24/2021

President of the University — Date

1. **Do you have a major in this?** ☐ Yes ☒ No

2. **If you do not have a major in this field, explain how the proposed minor relates to your university mission and strategic plan, and to the current Board of Regents Strategic Plan 2014-2020.**

   The mission of the University is provided in SDCL 13-58-1. The Legislature established South Dakota State University as the state's comprehensive land grant university. Board Policy 1:10:2 South Dakota State University Mission Statement authorizes service to

students and clients through teaching, research, and extension activities. The university offers baccalaureate and graduate programs in engineering, including mechanical engineering. Mechanical and aerospace engineering are often found combined in a single department in larger institutions. There is a significant amount of commonality of coursework and applications. The proposed minor supports the university's strategic plan to achieve excellence through transformative education by developing and growing high-quality and distinct academic programs designed to meet the needs of diverse students and market demands. The proposed minor supports the BOR Strategic Plan goal of recruiting, retaining and graduating students in STEM fields by providing the opportunity to earn a minor in an area of practice that is in demand both by students and industry.

3. What is the nature/purpose of the proposed minor? Please include a brief (1-2 sentence) description of the academic field in this program.

Aerospace Engineering is the primary field of engineering concerned with design and development of aircraft and spacecraft. Applications include traditional piloted fixed-wing and rotary-wing aircraft, as well as unmanned aircraft of various types. The minor specifies a sequence of courses and academic experiences that provide a basic background in concepts required to solve design problems in aerospace applications.

4. How will the proposed minor benefit students?

The Aerospace Engineering minor would provide students with enhanced knowledge in aerospace applications as well as opportunities for employment in aerospace-related industries and agencies.

5. Describe the workforce demand for graduates in related fields, including national demand and demand within South Dakota. *Provide data and examples; data sources may include but are not limited to the South Dakota Department of Labor, the US Bureau of Labor Statistics, Regental system dashboards, etc. Please cite any sources in a footnote.*

New versions of aircraft, especially autonomous fixed-wing and rotary wing types of various sizes are being continuously developed. The autonomous versions are becoming ubiquitous in a variety of applications, including production agriculture. Engineering expertise in aerospace systems design is required for development and refinement of these new designs.

Based on Bureau of Labor Statistics the expected growth in aerospace engineering jobs is about 3% from 2019 to 2029.[1] Another resource reported expected growth of about 6% from 2016 to 2026[2]. The median income for an aerospace engineer was listed as $116,500.[1]

There are at least six companies involved in aerospace/defense manufacturing in SD, accounting for a total of $61 million in sales.[3][4] In addition, South Dakota is home to Ellsworth Air Force Base with approximately 3600 military and civilian employees and the South Dakota Air National Guard 114th Fighter Wing with nearly 1100 assigned service members.

[1] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Aerospace Engineers, on the Internet at https://www.bls.gov/ooh/architecture-and-engineering/aerospace-engineers.htm (visited *October 15, 2020*).
[2] https://www.careerexplorer.com/careers/aerospace-engineer/job-market/
[3] https://www.zoominfo.com/companies-search/location-usa--south-dakota-industry-aerospace-defense
[4] https://www.aia-aerospace.org/research-center/statistics/state-level-data/

South Dakota State University hosts Detachment 780 of the Air Force Reserve Officers Training Corps. Engineering students in the AFROTC program would be able to enhance their career preparation with the Aerospace Engineering specialization.

6. Provide estimated enrollments and completions in the table below and explain the methodology used in developing the estimates.

	Fiscal Years*			
	1st	2nd	3rd	4th
Estimates	FY 22	FY 23	FY 24	FY 25
Students enrolled in the minor (fall)	10	12	15	20
Completions by graduates	0	6	10	12

*Do not include current fiscal year.

The faculty in the mechanical engineering department took a poll of senior students interested in an Aerospace Engineering minor in the Fall 2019 semester. Results from the survey are shown in the table below.

Class	No. of students that would enroll in minor	Total no. of students surveyed	Percent
ME 412 - Internal Combustion Engines	22	25	88%
ME 413 - Turbomachinery	20	22	91%
ME 451 - Automatic Controls	16	34	47%

Accounting for students enrolled in more than one of these courses, there were 15 senior students who indicated a desire to enroll in an Aerospace Engineering minor.

Some representative comments from the survey:

- I wanted this minor since freshman year.
- I wish this was already a minor.
- Would like more opportunity for aero classes and projects. Wanted it for a while.

SDSU anticipates that the number of enrolled students and the number earning the minor will approach that of the Sustainable Energy Systems minor which has been available for nearly ten years. In 2019-20 there were 31 students enrolled in the SSES minor and 26 graduates earned the minor.

7. What is the rationale for the curriculum? Demonstrate/provide evidence that the curriculum is consistent with current national standards.

Students completing the minor will gain an understanding of the basic concepts of solid mechanics and fluid mechanics required to design aircraft or spacecraft as well as advanced concepts in aerospace applications. The proposed aerospace engineering minor curriculum is modeled after aerospace engineering minors at other institutions. See Figure 1.

Michigan Technological University
Registrar's Office

Academic Year 2020-21
Minor in Aerospace Engineering (EMAE)
Department of Mechanical Engineering - Engineering Mechanics
Credits Required: 18

Student Name and ID Number

Required Courses: 10 credits minimum	**Credits**
MEEM 2150 Mechanics of Materials (3) **OR** ENG 2120 Statics-Strengths of Materials* (4)	
MEEM 3201 Intro Fluid Mechanics & Heat Transfer (4) **OR** ENG 3200 Thermodynamics/Fluid Mechanics* (4)	
MEEM 4810 Intro to Aerospace Engineering (3)	

Elective Courses: 4 credits minimum	**Credits**
ENT 4950 Enterprise Project Work V** (2)	
ENT 4960 Enterprise Project Work VI** (2)	
ENT 4961 Enterprise Project Work VII** (1)	
MEEM 4202 Int. Fluid Mech & Heat Transfer (3/4)	
MEEM 4210 Computational Fluids Eng. (3)	
MEEM 4701 Analytical & Experimental Modal Analysis (4)	
MEEM 4720 Space Mechanics (3)	
MEEM 4230 Compressible Flow/Gas Dynamics (3)	
MEEM 4820 Intro to Aerospace Propulsion (3)	
MSE 4430 Composite Materials (3)	

Remaining Elective Courses: select remaining credits from the following course list		**Credits**
MEEM 4150 Interm Mechanics of Materials (3)		
MEEM 4170 Failure of Materials in Mechanics (3)		
MEEM 4180 Engineering Biomechanics (3)		
MEEM 4201 Applied Thermodynamics (3)		
MEEM 4630 Human Factors (3)		
MEEM 4650 Quality Engineering (3)		
MEEM 4704 Acoustics and Noise Control (3)		
MEEM 4705 Intro to Robotics and Mechatronics (4)		
MEEM 4707 Autonomous Systems (3)		
MSE 4120 Material and Process Selection in Design(3)		
**Minor credit cannot be granted for ME majors for these two courses.*	**Credits Required = 18**	

***Requires minor advisor approval of project.*

Prerequisite courses can be found in the undergraduate catalog.

Figure 1: Aerospace Engineering minor from Michigan Tech.[5]

8. Complete the tables below. Explain any exceptions to Board policy requested.

A. Distribution of Credit Hours

Aerospace Engineering Minor	Credit Hours	Percent
Requirements in minor	12	67 %
Electives in minor	6	33 %
Total	18	100 %

[5] https://www.mtu.edu/registrar/students/major-degree/minors/audit/engineering/202008/minor-in-aerospace-engineering-emae.pdf

B. Required Courses in the Minor

Prefix	Number	Course Title	Prerequisites for Course	Credit Hours	New (yes, no)
EM	321	Mechanics of Materials	EM 214	3 (3) *	No
EM	331	Fluid Mechanics	EM 215	3 (3)	No
ME OR ME	311 314	Thermodynamics I Thermodynamics	PHYS 211-211L and EM 215	3 (7)	No
ME	431	Aerodynamics	EM 331	3	No
			Subtotal	12 (10)*	

*Credit hours in parentheses ( ) indicate prerequisite courses not counted in the minor requirements. The net number of prerequisite credits not counted is 10. These prerequisites are fundamental natural science (PHYS 211-211L) and engineering science (EM 214, EM 215) courses required to be taken by all engineering students who might choose to earn the minor and therefore are not applicable to the minor itself.

C. Elective Courses in the Minor: List courses available as electives in the program. Indicate any proposed new courses added specifically for the minor.

Select 6 credits from the following:

Prefix	Number	Course Title	Prerequisites for Course	Credit Hours	New (yes, no)
ME	413	Turbomachinery	EM 331 & ME 312	3 (6) *	No
ME	417-417L	Computer-Aided Engineering and Lab		3	No
ME	437	Gas Dynamics I	EM 331 & MATH 331	3 (6)	No
ME	441	Robotic Systems	ME 321	3 (3)	No
ME	442	Applications of Computational Fluid Dynamics	MATH 321, EM 331, & ME 311	3 (9)	No

*Credits in parentheses ( ) are prerequisites that are either required courses in the minor (EM 331, ME 311 or 314) or are required courses for engineering students who might choose to earn the minor (MATH 321, MATH 331, ME 312) and are therefore not applicable to the minor itself.

9. What are the learning outcomes expected for all students who complete the minor? How will students achieve these outcomes?

Students will gain a necessary knowledge of aerospace engineering and the impact of aerospace engineering solutions in the primary fields of aircraft and spacecraft. Students will develop skills to implement in the fields of professional, governmental, or academic environments in aerospace engineering. The following are the specific student outcomes for the Aerospace Engineering minor:

1. Ability to apply mathematics and engineering science to the design of structural elements, propulsion systems, and other fundamental components of aircraft or spacecraft;

- Achieved by successfully completing the required courses for the minor; augmented by completing one or more elective courses in turbomachinery, gas dynamics, or robotic systems;

2. Understanding of, and ability to apply the concepts of fluid mechanics and aerodynamics to the design of aircraft;
   - Achieved by successfully completing the required courses in fluid mechanics and aerodynamics; augmented by completing one or more elective courses in turbomachinery, gas dynamics and computational fluid dynamics;
3. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice in the aerospace industry;
   - Achieved by successfully completing projects in the aerodynamics course as well as in one or more of the technical elective courses;
4. An understanding of professional and ethical responsibility in engineering practice in the aerospace industry;
   - Achieved by studying design tradeoffs, modeling limitations and potential failure risks in required aerodynamics course and augmented in elective courses turbomachinery, gas dynamics and computational fluid dynamics;

	Program Courses that Address the Outcomes								
Individual Student Outcome	EM 321*	EM 331*	ME 311* or ME 314*	ME 431*	ME 413	ME 417-417L	ME 437	ME 441	ME 442
1. Ability to apply mathematics and engineering science to the design of structural elements, propulsion systems and other fundamental components of aircraft or spacecraft	X	X	X	X	X		X	X	
2. Understanding of, and ability to apply the concepts of aerodynamics to the design of aircraft		X		X	X		X		X
3. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice in the aerospace industry				X	X	X	X	X	X
4. An understanding of professional and ethical responsibility in aerospace engineering				X	X		X		X

10. What instructional approaches and technologies will instructors use to teach courses in the minor? *This refers to the instructional technologies and approaches used to teach courses and NOT the technology applications and approaches expected of students.*

Standard classroom technologies will be used. Face-to-face lecture will be the dominant instructional method.

11. Delivery Location

Note: The accreditation requirements of the Higher Learning Commission (HLC) require Board approval for a university to offer programs off-campus and through distance delivery.

A. Complete the following charts to indicate if the university seeks authorization to deliver the entire program on campus, at any off campus location (e.g., UC Sioux

Falls, Capital University Center, Black Hills State University-Rapid City, etc.) or deliver the entire program through distance technology (e.g., as an online program)?

	Yes/No	***Intended Start Date***
On campus	Yes	**2021-2022 Academic Year**

	Yes/No	***If Yes, list location(s)***	***Intended Start Date***
Off campus	No		

	Yes/No	***If Yes, identify delivery methods*** *Delivery methods are defined in AAC Guideline 5.5.*	***Intended Start Date***
Distance Delivery (online/other distance delivery methods)	No		
Does another BOR institution already have authorization to offer the program online?	No	**If yes, identify institutions:**	

B. Complete the following chart to indicate if the university seeks authorization to deliver more than 50% but less than 100% of the minor through distance learning (e.g., as an online program)? *This question responds to HLC definitions for distance delivery.*

	Yes/No	***If Yes, identify delivery methods***	***Intended Start Date***
Distance Delivery (online/other distance delivery methods)	No		

12. Does the University request any exceptions to any Board policy for this minor? Explain any requests for exceptions to Board Policy. *If not requesting any exceptions, enter "None."*

The University requests an exception to the Board policy that limits minors to a total of 18 credits, including prerequisites. The proposed Aerospace Engineering minor is intended only for students earning bachelor's degrees in engineering. Students will complete the prerequisites as part of the basic bachelor's degree requirements, regardless of the minor. The 18 credits included in the proposed minor prescribe a path to developing expertise in aerospace engineering through specific electives and focused experiential work.

13. Cost, Budget, and Resources: Explain the amount and source(s) of any one-time and continuing investments in personnel, professional development, release time, time redirected from other assignments, instructional technology & software, other operations and maintenance, facilities, etc., needed to implement the proposed minor. *Address off-campus or distance delivery separately.*

The Department of Mechanical Engineering already has the resources, personnel, and infrastructure required to implement the minor. No new investments are required at this time. The department has been building capacity for the minor for some time now. They invested $100,000 in a fully-instrumented gas turbine (jet) engine for the undergraduate lab several years ago. They have hired two faculty members with degrees and substantial experience in the aerospace industry. Jeffery Doom holds a Ph.D. in Aerospace Engineering and worked for GE Global Research in the Gas Turbine division before coming to SDSU. Marco Ciarcià holds an M.S. in Aerospace Engineering and a Ph.D. in M.E. with specialization in orbital mechanics and control. He had five years' experience in research at the Naval Postgraduate School in Monterey, CA before joining our faculty. Dr. Ciarcià also operates the Aerospace Robotics and Testbed Lab in the department. The Department has been regularly offering standard courses that are basic to aerospace engineering.

14. New Course Approval: New courses required to implement the new minor may receive approval in conjunction with program approval or receive approval separately. Please check the appropriate statement (*place an "X" in the appropriate box*).

☐ YES,
the university is seeking approval of new courses related to the proposed program in conjunction with program approval. All New Course Request forms are included as Appendix C and match those described in section 7.

☒ NO,
the university is not seeking approval of all new courses related to the proposed program in conjunction with program approval; the institution will submit new course approval requests separately or at a later date in accordance with Academic Affairs Guidelines.