Michigan Tech

Office Memo

Office of the Provost and
Senior Vice President for Academic Affairs

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TO: Richard Koubek, President

FROM: Jacqueline E. Huntoon, Provost & Senior Vice President for Academic Affairs

Jacqueline E Huntoon

DATE: November 18, 2020

SUBJECT: Senate Proposal 18-21

Attached is Senate proposal 18-21, "Establishment of a New Graduate Certificate in Aerodynamics," and a memo stating the Senate passed this proposal at their November 11, 2020 meeting. I have reviewed this memo and recommend approving this proposal.

I concur__X__ do not concur_______ with this recommendation.

____
Richard Koubek, President

11/19/20
Date

Michigan Tech

University Senate

DATE:	November 12, 2020
TO:	Richard Koubek, President
FROM:	Sam Sweitz University Senate President
SUBJECT:	Proposal 18-21
COPIES:	Jacqueline E. Huntoon, Provost & Senior VP for Academic Affairs

At its meeting on November 11, 2020, the University Senate approved Proposal 18-21, "Establishment of a New Graduate Certificate in Aerodynamics". Feel free to contact me if you have any questions.

The University Senate of Michigan Technological University
Proposal 18-21

Establishment of a New Graduate Certificate in Aerodynamics

Submitted by:
Department of Mechanical Engineering – Engineering Mechanics

1. **Proposal Date:** May 26, 2020
2. **Proposing Contacts and Departments:** Kazuya Tajiri, ktajiri@mtu.edu (ME-EM)
3. **Sponsor Department Approvals:** May 26, 2020
4. **General Description and Characteristics**

4.1. General Description: The objectives of the 9-credit Graduate Certificate in Aerodynamics are:

a) Attract engineering students to Michigan Tech who are interested in aerodynamics;

b) Provide a compact sequence for engineers seeking to refresh their fluid mechanics background and move into advanced concepts and applications.

c) Mentor engineers to develop best-practice skills in aerodynamics analysis using state-of-the-art tools, methods, and workflows.

4.2. Catalog Description: The Certificate in Aerodynamics develops a foundation of fundamental fluid dynamics of gases from low to high speed flows. Based on the fundamental understanding students can explore applications suited to their interests.

5. **The rationale for the Certificate**

Aerodynamics, or fluid dynamics of gases are ubiquitous in many aspects of engineering, not only for the flow around airplanes, but also for other transportation systems such as automotive and trains. These flows are analyzed with theoretical, experimental, and computational methods, but it is critical to understand the fundamentals of aerodynamics. Without fundamental understanding it is not possible to interpret the obtained results from experiments or computation.

The Aerodynamics Certificate will serve: (1) certificate-seeking students, who wish to obtain the skills to analyze the flow of gases as part of their professional development, and (2) degree seeking students who require the fundamental understanding of aerodynamics for their research or students with a passion for the topic.

6. **Related Programs**

Several similar certificates can be pursued online with a few examples shown below. Our proposed certificate is unique in its requirement and incorporation of fundamentals and hands-on experience through project-based opportunities. Several alternative/renewable energy intensive certificates can be pursued online, a couple of examples are outlined below.

1. ***University of Illinois Urbana Champaign*** – Aerodynamics and Flight Mechanics. 12 Semester Credits. Courses toward the certificate are Computational Aerodynamics, Viscous Flow & Heat Transfer, Applied Aerodynamics, Flight Mechanics, Aeroelasticity, and Wing Theory.

2. ***Duke University*** – Aerospace (on-campus only). 4 courses with attendance to seminars. Courses cover most of aerospace engineering field, including structures and dynamics, aerodynamics, acoustics, and computational methods.

7. Projected Enrollments

Table 1 shows estimated minimum targets assuming a more aggressive marketing approach is deployed. The enrollment cap depends on the number of sections that can be allocated to each course.

Table 1. Estimated minimum enrollment by year.

Academic Year	**Estimated Minimum Enrollment**	
	On-Campus	On-Line
2020-2021	5	3
2021-2022	7	5
2022-2023	10	10
2023-2024	10	10
2024-2025	10	10

8. Scheduling Plans

On-campus sections will not require changes to class scheduling while online sections can be implemented asynchronously.

9. Curriculum

This 9-credit certificate consists of one 3-credit required course and two 3-credit electives. Only three credits may be at the 4000 level. The required and elective course list with the course descriptions are given below. It is expected that students will work with the program advisor to select courses that fit their interests and prerequisite skills.

Required Courses - 3 credits

MEEM 5210 Advanced Fluid Mechanics (3 credits Fall)

Elective Courses - 6 credits (select 2 courses, only one 3-credit course at the 4000 level)

5000 level courses

MEEM 5215 Computational Fluids Engineering (3 credits Fall)
MEEM 5230 Advanced Heat Transfer (3 credits Fall)
MEEM 5240 Computational Fluid Dynamics for Engineering (3 credits Spring)
MEEM 5265 Physical Gas Dynamics (3 credits Spring – alternating year)

4000 level courses

MEEM 4202 Intermediate Fluid Mechanics and Heat Transfer (3 credits Fall)
MEEM 4230 Compressible Flow/Gas Dynamics (3 credits Spring)

10. Course Descriptions

MEEM 5210 – Advanced Fluid Mechanics – 3 credits
Develops control volume forms of balance laws governing fluid motion and applies to problems involving rockets, pumps, sprinklers, etc. Derives and studies differential forms of governing equations for incompressible viscous flows. Some analytical solutions are obtained and students are exposed to rationale behind computational solution in conjunction with CFD software demonstration. Also covers qualitative aspects of lift and drag, loss of stability of laminar flows, turbulence, and vortex shedding.

MEEM 5215 – Computational Fluids Engineering – 3 credits
This course introduces students into the theoretical and practical aspects of computational methods in fluid mechanics and thermal transport problems. Computer based tools are used to reinforce principles on advanced topics in thermo-fluids science.

MEEM 5230 – Advanced Heat Transfer – 3 credits
Advanced topics on conduction, convection, radiation, and heat exchangers are covered. Emphasis is on problem formulation, exact solutions, empirical correlations/results, and on computational techniques.

MEEM 5240 – Computational Fluid Dynamics for Engineering – 3 credits
Introduces finite-difference and finite-volume methods used in solving fluid dynamics and heat transfer problems. Covers numerical grid generation, turbulence modeling, and application to some selected problems.

MEEM 5265 – Physical Gasdynamics – 3 credits
Equilibrium gas kinetic theory, chemical thermodynamics, introduction to quantum and statistical mechanics, flow with finite rate (e.g. vibrational energy relaxations, and chemical reactions), nonequilibrium kinetic theory, selected gas kinetic related computational methods.

MEEM 4202 – Intermediate Fluid Mechanics and Heat Transfer – 3 credits
Intermediate fluid mechanics and heat transfer topics are covered. These include necessary considerations of: differential analysis of fluid flows based on Navier-Stokes equations, lift and drag, convective heat transfer in external flows, radiation, and simple considerations of condensation and boiling.

MEEM 4230 – Compressible Flow/Gas Dynamics – 3 credits
Fundamentals of one-dimensional gas dynamics, including flow in nozzles and diffusers, normal shocks, frictional flows, and flows with heat transfer or energy release, introduction to oblique shocks.

11. Model Schedule Demonstrating Completion Time

The minimum completion time is one semester, but two or three semesters are recommended. Sample schedules are shown below.

Fall Semester
MEEM 5210
MEEM 5230
MEEM 5215

Fall Semester	***Spring Semester***
MEEM 5210	MEEM 5240
MEEM 5230	

Fall Semester	***Spring Semester***	***Fall Semester***
MEEM 5210	MEEM 5240	MEEM 5230

12. Library and Other Learning Resources

None

13. Faculty Resumes

The associated faculty who taught or can teach related courses, are given below.

Dr. Jeffrey S. Allen
https://www.mtu.edu/mechanical/people/faculty/yang/

Dr. Sajjad Bigham
https://www.mtu.edu/mechanical/people/faculty/bigham/

Dr. Chunpei Cai
https://www.mtu.edu/mechanical/people/faculty/cai/

Dr. L. Brad King
https://www.mtu.edu/mechanical/people/faculty/king/

Dr. Seong-Young Lee
https://www.mtu.edu/mechanical/people/faculty/lee/

Dr. Hassan Masoud
https://www.mtu.edu/mechanical/people/faculty/masoud/

Dr. Amitabh Narain
https://www.mtu.edu/mechanical/people/faculty/narain/

Dr. Fernando Ponta
https://www.mtu.edu/mechanical/people/faculty/ponta/

Dr. Kazuya Tajiri
https://www.mtu.edu/mechanical/people/faculty/tajiri/

Dr. Song-Lin (Jason) Yang
https://www.mtu.edu/mechanical/people/faculty/yang/

14. Equipment
None

15. Program Costs
There are no new costs in offering this certificate to on-campus students. Costs will be incurred for the on-line version to cover (1) initial online content and (2) adjust online content for new software versions and examples. These costs can be met assuming the tuition return to departments is not decreased.

16. Space
None

17. Policies, Regulations, and Rules
None

18. Accreditation Requirements
Michigan Tech is accredited by the Higher Learning Commission (HLC) (https://www.mtu.edu/provost/accreditation/hlcommission/). The proposed certificate will not require additional accreditation. The proposed certificate will meet HLC criteria 3 and 4.

19. Implementation Date
Spring 2021

20. Assessment
The Graduate Student Learning Objectives (GLO) of the Certificate are: Upon completion of the Certificate the student should be able to

1. Solve the fundamental problems in aerodynamics given a physical description of a system, following the standard process of
    1. define a suitable control surface or volume
    2. list the appropriate set of governing equations
    3. apply the necessary simplifications and approximations
    4. solve the governing equations analytically or numerically
2. Apply the standard solution procedure to specific aerodynamics problems,
3. Communicate the analysis process in aerodynamics, through written project reports, including: statement of assumptions, derivation of governing equations, solution processes, and validation of the solutions.

Department approval: March 27, 2020

College of Engineering approval: May 28, 2020