

**The University Senate of Michigan Technological University**  
**Proposal 13-21**  
(Voting Units: Academic)

**Establishment of a New Graduate Certificate in  
Fundamentals of Materials Engineering**

**Submitted by: Department of Materials Science and Engineering**

**1. Proposal Date:**

June 3, 2020; revised December 10, 2020

**2. Proposing Contacts and Department:**

D.J. Swenson, Materials Science and Engineering

**3. Sponsor Department Approvals**

Materials Science and Engineering

**4. General Description and Characteristics of Program:**

**4.1 General Description of Certificate**

The certificate in Fundamentals of Materials Engineering is a ten-credit program of one required course and three electives designed to provide a basic understanding of the physical principles required to apply the Processing-Structure-Properties-Performance paradigm of the MSE discipline. The program of study provides a basic understanding of the concepts required to analyze, design and control the development and optimization of new and emerging materials for current or emerging applications. Recipients of this certificate will be able to apply thermodynamic and kinetic principles to design the materials chemistry and the manufacturing processes required to develop specific material microstructures and functionalities. The coursework is delivered at the graduate level, so formal educational credentials in the physical sciences (engineering, physics, chemistry) is a required for admission into the certificate program. This certificate would be of interest to engineers/students involved/interested in material and product development, manufacturing and design. The certificate will be offered on campus and fully on-line.

**4.2 Catalog Description**

The Certificate in Fundamentals of Materials Engineering is designed to develop skills and competencies in materials design and processing techniques, including thermodynamics of materials chemistry, kinetics of microstructure development, materials characterization and materials properties. In addition, the curriculum integrates building skills in communication, project development and literature review from real-world problems.

- 5. Rationale for Certificate:** The rationale for this certificate can be found in the introduction of the policy document <https://www.osti.gov/servlets/purl/1074252> as described in the quote below:

“Designers and engineers achieve functional and lasting designs through thoughtful consideration, evaluation, development and application of material to exploit the material properties and envelope the operational and environmental requirements. Materials can yield technology leaps and promise quite significant capability, safety, environmental, or manufacturing benefits; and too, may come with disadvantageous trade-offs that need characterization and control.”

The proposed courses within this certificate are offered online, as well as face to face, such that engineers in the field may earn the certificate.

**6. Related Programs:**

NCSU: <https://online-distance.ncsu.edu/program/graduate-certificate-in-materials-science-and-engineering/>

The Graduate Certificate in Materials Science and Engineering (MSE) is designed for working professionals who do not have formal training in MSE, but wish to acquire a basic understanding of materials science. The program requires four courses (12 credit hours) and can be completed in two semesters. Most people enroll as distance education students. Required courses include the core course MSE 500 (3 credit hours) and three MSE elective courses (9 credit hours) selected by the student. Students may customize their particular program to focus on specific areas of materials science that interest them.

Columbia: <https://cvn.columbia.edu/program/columbia-university-materials-science-certification-certificate>

Materials Science and Engineering is a rapidly growing, multidisciplinary activity that has emerged as a recognizable field in recent decades. Scientists and engineers in this field lay the basis for understanding, developing, testing, and applying materials that form the foundation for present and future technologies (for example, ceramic engines for the automotive industry, semiconductor devices for the microelectronic industry, and polymers and composite materials for various industries including sports and automotive industries). More significantly, the choice and power of future human endeavors will depend critically on the development of improved and environmentally-sound materials, whether as inexpensive and highly efficient solar cells for clean power generation or as radiation-resistant alloys for fusion reactor walls.

LSU: <http://www.mse.lsu.edu>

The Interdisciplinary Certificate Program in Materials Science and Engineering is designed to provide both current LSU graduate students and new graduate students in the College of Engineering and College of Science an opportunity to enhance their career opportunities in industry, government laboratories, academia, and entrepreneurship. The program emphasizes the multidisciplinary nature of the study of materials and the engineering application of their properties.

## 7. Projected Enrollments: Related Programs

We anticipate significant enrollment from both MSE's on-campus and distance MS and PhD graduate students, plus students from related fields that have an interest in the materials side of their discipline. Interest from students enrolled in peer graduate programs seeking transferrable coursework is also anticipated.

Semester	On-campus Enrollment	On-line Enrollment
Fall 2021	10	5
Fall 2022	10	5
Fall 2023	12	6
Fall 2024	12	8
Fall 2025	15	10

## 8. Scheduling Plans:

No change in the regular scheduling of the existing courses is anticipated. The departments delivering the online courses have agreed to fit them into their regular scheduling plans. Courses will be available online throughout the academic year and during summer semester.

## 9. Curriculum Design:

Required Coursework: 1 credit

- **MSE5970 - Special Topics - Graduate Materials Science and Engineering**,  
1 cr. Topic: Perspectives on Computational Materials Science;  
Restrictions: Permission of the Department  
(permission will be granted in the student's last semester of the certificate)

Elective Coursework: 9 credits

- **MSE 5110 - Thermodynamics and Kinetics I** Solution thermodynamics and application to phase equilibria. Driving force for phase transformations. Chemical thermodynamics applied to materials processing. Corrosion and oxidation of metals. Applications to engineering situations.  
Lec-Rec-Lab: (3-0-0)  
Semesters Offered: Fall  
Restrictions: Must be enrolled in one of the following Level(s): Graduate
- **MSE 5120 - Thermodynamics and Kinetics II** The kinetics of liquid-to-solid and solid-to-solid phase transformations. Diffusion- controlled phase transformations, including nucleation, growth, coarsening, spinodal decomposition, eutectic and eutectoid transformations, cellular transformations, and massive transformations. Martensitic transformations.  
Credits: 3.0  
Lec-Rec-Lab: (3-0-0)  
Semesters Offered: Spring  
Restrictions: Must be enrolled in one of the following level(s): Graduate Pre-Requisite(s): MY 5100 or MSE 5110
- **MSE 5130 - Crystallography & Diffraction** Crystallographic concepts and diffraction analyses in materials science.  
Credits: 3.0  
Lec-Rec-Lab: (2-0-3)  
Semesters Offered: Spring  
Restrictions: Must be enrolled in one of the following Level(s): Graduate

- **MSE 5140 - Mechanical Behavior of Materials** Deformation-related physical behaviors of materials in the mathematical framework of tensor analysis. Material symmetry and tensor property. Stress, strain, and elastic constitutive relation. Non-elastic strain, thermomechanical, electromechanical, and magnetomechanical behaviors.  
Credits: 3.0  
Lec-Rec-Lab: (3-0-0)  
Semesters Offered: On Demand  
Restrictions: Must be enrolled in one of the following Level(s): Graduate

## 10. Model Schedule Demonstrating Completion Time

The certificate is designed to be completed in 2 semesters; *e.g.*,

### Fall Semester

MSE5110  
and/or MSE5140

### Spring Semester

MSE5970  
MSE5120  
and/or MSE5140

## 11. Library and other Learning Resources

No library or other learning resources are required at this time.

## 12. Faculty Resumes

The following members of the graduate faculty will participate in the program as course instructors.

Prof. Steve Hackney  
Prof Yongmei Jin  
Dr. Edward Laitila  
Prof. Doug Swenson  
Prof. Yu Wang

## 13. Equipment

No additional equipment will be required.

## 14. Program Costs

Initial costs for offering the certificate will not incur additional costs. As online/remote instruction enrollment grows, the additional costs associated with instruction will be covered from tuition return from the students who are enrolled online.

## 15. Space

There are no new space requirements.

## 16. Policies, Regulations, and Rules

Not applicable

## 17. Accreditation Requirements

Michigan Tech is accredited by the Higher Learning Commission (HLC). The proposed certificate will meet HLC criteria 3 and 4. The proposed certificate will not seek additional accreditation.

**18. Planned Implementation Date:** Fall 2021

**19. Assessment**

Upon completion of the Graduate Certificate in the Fundamentals of Materials Science and Engineering, the student will be able to:

1. propose and/or design new materials based on structure-property correlations
2. propose and/or design processing based on processing-structure correlations
3. Predict material structure based on fundamental principles of material thermodynamics and kinetics

**Approval Process**

Departmental Graduate Committee: June 4, 2020  
Department: June 4, 2020; revised December 10, 2020  
College of Engineering: June 9, 2020  
Provost's Office and Deans' Council: June 17, 2020  
Graduate School: June 23, 2020  
Approved by the Senate:  
Approved by the President: