The University Senate of Michigan Technological University
Proposal 6-21

(Voting Units: Academic)

Establishment of a New Graduate Certificate in Structural Engineering: Advanced Analysis

Submitted by: Department of Civil and Environmental Engineering

1. Proposal Date:
May 15, 2020

2. Proposing Contacts and Department:
- Dr. Theresa M. Ahlborn, Department of Civil and Environmental Engineering, tess@mtu.edu
- Dr. William M. Bulleit, Department of Civil and Environmental Engineering, wmbullei@mtu.edu
- Dr. Qingli Dai, Department of Civil and Environmental Engineering, qingdai@mtu.edu
- Dr. Daniel M. Dowden, Department of Civil and Environmental Engineering, dmdowden@mtu.edu
- Dr. Stephen M. Morse, Department of Civil and Environmental Engineering, smmorse@mtu.edu
- Dr. R. Andrew Swartz, Department of Civil and Environmental Engineering, raswartz@mtu.edu

3. Sponsor Department Approvals: May 29, 2020

4. General Description and Characteristics of Program:

4.1 General Description of Certificate
The structures faculty in the department of Civil and Environmental Engineering within the College of Engineering at Michigan Tech proposes a nine credit Certificate named Structural Engineering: Advanced Analysis. In addition to practicing structural engineers, individuals with an engineering background with an interest in structural analysis, will find the skills covered in this Certificate to be of use.

The proposed certificate provides individuals with the ability to perform analysis of structures under static and dynamic loadings including large deformation effects, post-yield behavior, and non-standard and unusual geometries. Analysis methods taught as part of this certificate go significantly beyond those at the undergraduate level.

4.2 Catalog Description

This certificate covers the modern, advanced structural analysis tools and techniques necessary for analysis of large and inherently complex structures, structures that exhibit finite deformations, structures loaded beyond their first yield point, and structures that experience dynamic loads.

5. **Rationale for Certificate:**

The skills gained here will be to utilize advanced techniques to evaluate structures to determine the response to load effects due to dead, live and environmental loads applied to the structure. The dynamic response of single- and multi-degree structures is explored using exact analytical and numerical methods. Analysis skills learned as part of this certificate are very useful and necessary for career advancement of structural engineers in the technical track at larger engineering firms and other companies and agencies that focus on design and analysis of large and complex structures.

This certificate will be offered primarily online and will be available to anyone around the world. Graduate students who want this stackable certificate that would count towards a full MS degree would benefit from this certificate. Also benefiting from this certificate would be working professionals, particularly those already holding undergraduate engineering degrees, who want to expand their skills to analysis of structures. The online versions of these courses are already components of an existing online MSCE degree offering, thus they are currently online, or are planned to be online within the next two years. This program draws a significant number of MTU alumni and other students. Offering these courses as part of a certificate will increase these numbers to include students seeking only certificates as well. In addition, the certificate can attract full-time working professionals who do not find an MS degree necessary to achieve their goals.

6. **Related Programs:**

University of Central Florida
Structural engineering graduate certificate
12 credit hours
https://catalog.ucf.edu/preview_program.php?catoid=4&poid=1334&returnto=239

University of Kentucky
Structural engineering graduate certificate
9 credit hours
https://www.engr.uky.edu/research-faculty/departments/civil-engineering/students/graduate-program/graduate-certificate

The George Washington University
Structural engineering graduate certificates (4 options)
12 credit hours
https://www.cee.seas.gwu.edu/structural-engineering-graduate-certificate-program

The Citadel
Graduate certificate in structural engineering
12 credit hours
https://www.citadel.edu/root/cee-graduate-programs/structural-engineering

University of Louisville
Online graduate certificate in structural engineering
12 credit hours
http://louisville.edu/online/programs/certificate-programs/structural-engineering

University of Alabama at Birmingham
Structural engineering, graduate certificate
15 credit hours
https://www.uab.edu/degrees/graduate/structural-engineering-gc

The University of Kansas
Graduate certificate in structural design
12 credit hours
https://catalog.ku.edu/engineering/civil-environmental-architectural-engineering/certificate-structural-design/

7. **Projected Enrollments:**
   The primary market for this certificate is expected to be online students who are currently working as engineers and are looking to enhance their career prospects. Also, students who are currently enrolled in the Civil Engineering online professional M.S. program are expected to enroll in this certificate program in order to add value to their work as they progress. Additional students are expected to enroll as certificate-seeking students, perhaps converting to degree-seeking roles after completion of one (or more) certificate(s).

   The courses that are part of this certificate already exist and are taught on ground. Some of these courses have also been developed for online, asynchronous learning with the remaining courses to be developed for online by the Spring of 2022.

Semester	On-campus Enrollment	On-line Enrollment
Fall 2021	12	20
Fall 2022	14	24

Fall 2023	16	28
Fall 2024	20	32

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:** The certificate is designed to be completed in 3 semesters. Online students that have other, full-time employment obligations tend to want to take a single graduate-level course at a time. **Only 3 credits at the 4000-level may be applied to this 9-credit certificate.**

   Required Coursework: 3 credits
   CEE4201: Matrix Structural Analysis (3, Fall, Spring)

   Elective Coursework: choose 6 credits from the following
   CEE5201: Advanced Structural Analysis (3, Spring)
   CEE5202: Finite Element Analysis (3, Spring)
   CEE5241: Structural Dynamics (3, Fall, Summer)

10. **Course Descriptions:**
    CEE 4201: Matrix Structural Analysis
    Analysis of trusses and frames by the direct stiffness method. Use of a typical commercial computer code is stressed as a tool for complex structures. Introduces three-dimensional structures.

    CEE 5201: Advanced Structural Analysis
    The study of nonlinear structural analysis techniques, especially energy methods, applied to elastic buckling analysis, large deflections of beams, second-order effects in frames, plastic analysis of steel structures, and yield analysis of concrete beams and slabs.

    CEE 5202: Finite Element Analysis
    Introduction to the use of finite element methods in structural analysis. Covers the finite element formulation, 1- and 2-D elements, including isoparametric elements, axisymmetric analysis, plate and shell elements, dynamics, buckling, and nonlinear analysis.

    CEE 5241: Structural Dynamics

Free and forced vibration of undamped and damped single degree of freedom systems. Seismic design using the equivalent lateral force method. Introduction to multi-degree of freedom systems and transmissibility.

11. **Model Schedule Demonstrating Completion Time**
The certificate is designed to be completed in 3 semesters.

Fall Semester
CEE4201: Matrix Structural Analysis

Spring Semester
CEE5201: Advanced Structural Analysis
 -or-
CEE5202: Finite Element Analysis

Summer Semester
CEE5241: Structural Dynamics

12. **Library and other Learning Resources**
No library or other learning resources are required at this time.

13. **Faculty Resumes**
The following faculty will be supporting the program.

- Dr. Theresa M. Ahlborn, Department of Civil and Environmental Engineering,
  - https://www.mtu.edu/cee/people/faculty-staff/faculty/ahlborn/
- Dr. William M. Bulleit, Department of Civil and Environmental Engineering,
  - https://www.mtu.edu/cee/people/faculty-staff/faculty/bulleit/
- Dr. Qingli Dai, Department of Civil and Environmental Engineering,
  - https://www.mtu.edu/cee/people/faculty-staff/faculty/dai/
- Dr. Daniel M. Dowden, Department of Civil and Environmental Engineering,
  - https://www.mtu.edu/cee/people/faculty-staff/faculty/dowden/
- Dr. Stephen M. Morse, Department of Civil and Environmental Engineering,
  - https://www.mtu.edu/cee/people/faculty-staff/faculty/morse-s/
- Dr. R. Andrew Swartz, Department of Civil and Environmental Engineering,
  - https://www.mtu.edu/cee/people/faculty-staff/faculty/swartz/

14. **Equipment**
No additional equipment will be required.

15. **Program Costs**
Initial costs for offering the certificate will not incur additional costs, but as enrollment grows additional instructional resources will be needed.

16. Space

There are no new space requirements.

17. Policies, Regulations, and Rules

Not applicable

18. Accreditation Requirements

The proposed certificate will not seek additional accreditation.

19. Planned Implementation Date

Spring 2021

20. Assessment

The learning objective of the Certificate is:

1. Apply advanced structural analysis skills for linear and nonlinear structural behaviors under static and dynamic loads using both numerical and closed-form analysis types.

21. Approval Process

Departmental Graduate Committee: May 15, 2020
Department: May 29, 2020
College of Engineering: June 2, 2020
Provost's Office and Deans' Council: June 10, 2020
Graduate School: June 23, 2020
Approved by the Senate:
Approved by the President: