The University Senate of Michigan Technological University
Proposal 8-21

(Voting Units: Academic)

Establishment of a New Graduate Certificate in Structural Engineering: Building Design

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: Building Design. 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 design tasks for building structures, including advanced connections, complex structures, and system-level building design. The proposed certificate is designed with some flexibility in mind, allowing students to choose to study high-level design topics spanning multiple material systems, or to focus within a single material system. Design methods taught as part of this certificate go significantly beyond those at the undergraduate level.

4.2 Catalog Description

Material covered in this certificate includes advanced connections, complex structures, and system-level building design. The certificate has some flexibility, allowing students to choose to study high-level design topics spanning multiple material systems, or to focus within a single material system. Design methods taught as part of this certificate go significantly beyond those at the undergraduate level.

5. Rationale for Certificate:

The skills gained here will be to utilize advanced techniques to evaluate structures to design building components and systems in structural steel, reinforced and prestressed concrete, masonry, and/or timber. Course work focuses on component and system design, design of connections, design of complex structural systems, and design for complex behaviors. Students can choose to focus on a single structural material category (e.g., timber or concrete) or pursue high-level design skills in multiple material specialties. Students are limited to being able to count only one 4000-level course option toward the certificate, thus preventing them from using the graduate-level certificate to replicate the structural design portion of a civil engineering undergraduate degree. Design 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 building design.

This certificate will be offered primarily online. 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 structural building design. 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. For students taking a 4-credit 4000 level course, only 3 of 4 credits will be applied. Students are responsible to ensure that they are able to meet the prerequisite requirements for the courses that they wish to take.

Elective Coursework: choose 9 credits from the following
(only 3 credits at the 4000 level may be taken)

Choose one of the following:
CEE4213: Structural Concrete Design (4 cr., Spring)
CEE4223: Steel Design I (4 cr., Fall, Summer)
CEE4233: Structural Timber Design (3 cr., Spring)
CEE4244: Loads for Civil Structures (3 cr., Spring)

Choose two of the following:
CEE5201: Advanced Structural Analysis (3 cr., Spring)
CEE5212: Prestressed Concrete Design (3 cr., Fall)
CEE5213: Concrete and Masonry Building Systems (3 cr., Fall, Summer)
CEE5223: Steel Design II (3 cr., Spring, Summer)
CEE5233: Advanced Structural Timber Design (3 cr., Fall)

5. Course Descriptions:

CEE 4213: Structural Concrete Design (4 cr.)

Introduction to design of reinforced concrete structural components. Analyze and design reinforced concrete beams, columns, and footings. Understand material behavior, limit state criteria, and practical detailing considerations. Application of the ACI 318 to cast-in-place and precast systems.

CEE 4223: Steel Design I (4 cr.)

Behavior and design of structural steel members using both ASD and LRDF approaches. Covers material behavior, external loads, and the design of tension, compression, and flexural members (rolled, built-up, and composite), and simple welded and bolted connections.

CEE 4233: Structural Timber Design (3 cr.)

Introduction to the use of wood as a structural engineering material. Includes design of beams, columns, nailed and bolted connection, glulam members, including tapered beams, tapered and curved beam, and design of wood shear walls and diaphragms.

CEE 4244: Loads for Civil Structures (3 cr.)

The course focuses on the theory and building code requirements for civil structural loadings that are used in design. The loads and load combinations will include dead loads, occupancy live loads, snow loads, wind loads, and seismic loads.

CEE 5201: Advanced Structural Analysis (3 cr.)

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 5212: Prestressed Concrete Design (3 cr.)

Theory of prestressed and post-tensioned members. Covers analysis and design of prestressed concrete beams, slabs, box girders, and bridge girders by elastic and ultimate strength methods. Precast and cast-in-place system construction techniques will be included.

CEE 5213: Concrete and Masonry Building Systems (3 cr.)

Design of reinforced concrete two-way slabs and reinforced masonry systems for buildings. Includes design of bearing walls, shear walls, lintels, pilasters, slender columns, torsional beams and connections. A design project may be included during the semester.

CEE 5223: Steel Design II (3 cr.)

Additional topics in steel design including beam-columns, floor vibrations, diaphragms, buckling behavior of thin elements, torsional buckling, and beam and column bracing. Includes an introduction to cold-formed steel design.

CEE 5233: Advanced Structural Timber Design (3 cr.)

Advanced design of timber structures, including arches and traditional timber frames, advanced shear wall design, advanced connection design, including timber connectors, and advanced analysis and behavior of wood, including cumulative damage modeling.

11. Model Schedule Demonstrating Completion Time

The certificate is designed to be completed in 3 semesters. Many options exist to complete the certificate. Three possible options are shown below, each with a different starting semester.

Option 1: Steel Concentration

Fall Semester
CEE4223: Steel Design I

Spring Semester
CEE5201: Advanced Structural Analysis

Summer Semester
CEE5223: Steel Design II

Option 2: Cementitious Materials Concentration

Spring Semester
CEE4213: Structural Concrete Design

Summer Semester
CEE5213: Concrete and Masonry Building Systems

Fall Semester
CEE5212: Prestressed Concrete Design

Option 3: Advanced Building Systems Concentration

Summer Semester
CEE5223: Steel Design II

Fall Semester
CEE5212: Prestressed Concrete Design

Spring Semester
CEE4233: Structural Timber Design

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. Design building components and connections for gravity and lateral loads with a range of structural materials using current building code specifications and standards.

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: