The University Senate of Michigan Technological University
Proposal 17-21
(Voting Units: Academic)

Establishment of a New Graduate Certificate in Water Resources Modeling

Submitted by: Department of Civil & Environmental Engineering

1. **Proposal Date:**
   May 28, 2020

2. **Proposing Contacts and Department:**
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   Department of Civil & Environmental Engineering

   John S. Gierke, Ph.D., P.E. jsgierke@mtu.edu
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3. **Sponsor Department Approvals**
   At the end of the document

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

4.1 General Description of Certificate

This Civil & Environmental Engineering Department at Michigan Technological University proposes a nine-credit Certificate in Water Resources Modeling. The graduate certificate in Water Resources Modeling has the following three objectives:

i) attract students who want to learn or improve modeling skills using data/large data and computer programming, and to use models for engineering design and system analysis;
ii) to teach students applied model building skills, including visualization, interpretation, and communication of results, and;

iii) to provide students fundamental skills in numerical modeling and simulation, including calibration, validation, and assessment of model performance for use in natural and engineered systems.

4.2 Catalog Description

The Certificate in Water Resources Modeling is designed to develop skills and competencies in modeling natural and engineered hydraulic and hydrologic systems, including simulation and large data analysis. In addition, the curriculum builds skills for system analysis, design, and communication, while working with data from real-world case studies.

5. Rationale for Certificate:

The Water Resources Modeling Certificate will serve three student populations. First, the certificate will provide students in civil and environmental engineering at Michigan Tech with a path to gaining skills and knowledge in computational methods in water resources engineering. This pathway would be available to current students on-campus or students enrolled online.

Second, current Michigan Tech graduate students from a wide range of disciplines are seeking to equip themselves for our data-driven world. The proposed Graduate Certificate will provide academic training in modeling to students from various backgrounds including physical sciences, geosciences, computational sciences, and engineering. This nine-credit certificate will provide a strong foundation in modeling of natural and engineered systems that most students can fit into their curriculum.

Third, working professionals in civil/environmental or other engineering disciplines may require skills and knowledge they did not gain during their undergraduate education but are required for projects and research opportunities that are presented in their current career. Anecdotal evidence that companies would like to be able to hire graduates with more in-depth modeling experience includes comments from a former student along with their recruiter during a recent Michigan Tech career fair. They said that modeling and programming experience using big data are essential for new hires. Therefore, another intended audience for the certificate consists of Michigan Tech graduate students in STEM disciplines who want to broaden their marketability by adding data analysis to their skill set. Additionally, professionals have inquired for advice as to how to learn in-depth modeling outside of their current career for their immediate use because structured means to do so currently do not exist online, time in their job does not allow, and/or a professional with these skills in their immediate office does not exist. Additionally, numerous water resources position advertisements are requiring applicants to be able to develop and apply hydrologic,

hydraulic, and 2D hydrodynamic models; analyze and manage large datasets; and develop digital systems for monitoring, control, and real-time decision support.

6. Related Programs:

There are several related online water resources engineering programs. Examples include:

- Colorado State University Online, Fort Collins, Colorado. Colorado State University offers two water resources certificates: The first concentrates on water resources planning and management, engineering hydrology, and irrigation systems; Nine credits are selected from fifteen 3-credit courses. The second, concentrates on career advancement in water resources planning, management, and policy for working professionals in the public or private sector. Nine credits are selected from four 3-credit courses. https://www.online.colostate.edu/topics-of-study/water/

- Old Dominion University Coastal Engineering Certificate Program (CECP), Norfolk, Virginia. The certificate consists of four 3-credit courses. The program focus is to provide practicing engineers the opportunity to study Coastal Engineering at the graduate level. https://www.odu.edu/eng/research/institutes-labs/cei/coastal-engineering-certificate-program-cecp#https%3A//www.odu.edu/eng/research/institutes-labs/cei/coastal-engineering-certificate-program-cecp%23=&tab4=1

- California State University, Sacramento – Graduate certificate in Engineering Hydraulics (12 credits). This certificate offers a basic hydrologic modeling course. https://catalog.csus.edu/colleges/engineering-computer-science/engineering-civil/certificate-in-engineering-hydraulics/

- University of Arizona – Hydraulics and Water Resources Engineering (Certificate). This certificate has one basic water modeling course that appears to be a combination of CEE 4620 and CEE 4507. This certificate does not appear to be online. https://grad.arizona.edu/catalog/programinfo/HWECRTG

- Villanova University, Urban Water Design and Dam Engineering. This certificate has one course in watershed modeling and is focused more on urban settings, unlike the proposed certificate. https://www1.villanova.edu/villanova/engineering/departments/cee/graduate/certificates.html

7. Projected Enrollments:

Initially, the majority of enrollment will consist of current Michigan Tech students. CEE 4620 currently has 11 students enrolled for Fall 2020. An online offering will expand the number of students enrolled. Given the current level of interest, we expect the program to grow over the next several academic years. If enrollment exceeds projections, in particular through online enrollment, additional resources will be required (see section 15 below).

Semester	On-campus Enrollment	On-line Enrollment
Fall 2021	10-15 students	2-5 students
Fall 2022	10-15 students	5-10 students
Fall 2023	10-15 students	10-15 students
Fall 2024	10-15 students	15-20 students

8. Scheduling Plans:

No change in the regular scheduling of the existing courses is anticipated.

9. Curriculum Design:

Elective Coursework: 9 credits, choose 3 courses for certificate completion (only 3 credits may be at the 4000 level):

CEE 4620 River & Floodplain Hydraulics (3, Fall)
CEE 5610 Water Resources System Modeling & Design (new dual listed course) (3, Spring)
CEE5504 Water Quality Modeling in Natural Systems (3, Spring)
CEE5520 Hydrodynamic Modeling (3, Spring)
GE 5850 Advanced Groundwater Engineering and Remediation (3, on demand)

10. Course Descriptions

****CEE 4620, River & Floodplain Hydraulics** (3 cr., Fall)
Analysis of open channel systems, including natural channels, designed channels, flow transitions, non-uniform flow, and unsteady flow.

****CEE 4610 Water Resources System Modeling & Design** (3 cr. Spring)
(link to new Course Proposal)

CEE 5610 Water Resources System Modeling & Design (3 cr., Spring
(link to new Course Proposal)
Solve complicated, open-ended real-world water resources problems in natural and built systems by developing and executing models using state of the practice technologies. Includes programming to manage large datasets and validation or calibration and optimization of models for design.

CEE5504 Water Quality Modeling in Natural Systems (3 cr., Spring)
Principles of surface water quality management are introduced and examined in the context of the mathematical models used to design and test lake and river management strategies. Case histories and guest lectures will be provided to broaden students' exposure.

CEE5520 Introduction to Hydrodynamic Modeling (3 cr., Spring)
Introduce fundamental concepts and numerical methods used in hydrodynamic modeling, physical processes in the hydrodynamic system and their numerical representation using governing equations. Students construct simplified numerical models with application to problems of coastal oceans and large lakes, as well as engineering systems of interest to environmental and other engineers.

GE 5850 Advanced Groundwater Engineering and Remediation (3 cr., on demand)
Computer modeling and other advanced topics in the analysis of hydrological systems, contaminant transport and fate, and subsurface remediation systems.

Notes:
**Only up to 3 credits at the 4000 level can be used toward the certificate.

11. Model Schedule Demonstrating Completion Time

The Certificate can be completed in a 1 or 2 semester sequence or spread over 3 semesters (depending on student preference and scheduling requirements). The courses are offered in the semester listed below. Students can start any semester for increased flexibility. Once courses are all online, faculty may teach the courses other semesters as overload. For additional flexibility, if the course is not offered in a given semester due to low enrollment numbers, faculty sabbaticals, etc., courses may be substituted as approved by the student's advisor and a faculty member listed on the certificate and/or the graduate program director. A 2-semester example schedule is shown below.

Fall Semester
CEE 4620, River & Floodplain Hydraulics

Spring Semester
CEE 5610 Water Resources System Modeling & Design
CEE5504 Water Quality Modeling in Natural Systems

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.

Melanie Kueber Watkins, Ph.D., P.E., Research Assistant Professor
https://www.mtu.edu/cee/people/faculty-staff/faculty/kueber-watkins/

Cory McDonald, Ph.D., Assistant Professor
https://www.mtu.edu/cee/people/faculty-staff/faculty/mcdonald/

Pengfei Xue, Ph.D., Associate Professor
https://www.mtu.edu/cee/people/faculty-staff/faculty/xue/

Brian Barkdoll, Ph.D., PE, Professor
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David W. Watkins, Ph.D., PE, Professor
https://www.mtu.edu/cee/people/faculty-staff/faculty/watkins/

Veronica Webster, Ph.D., PE, Associate Professor
http://www.cee.mtu.edu/webster/

John S. Gierke, Ph.D., P.E., Professor
https://www.mtu.edu/geo/department/faculty/gierke/john-gierke-cv.pdf

14. Equipment

No additional equipment will be required.

15. Program Costs

Initially, the certificate will not incur additional costs, as we anticipate that the initial enrollment load can be covered with our current faculty. As online instruction enrollment grows, the additional costs associated with instruction will be covered from tuition return from the students who are enrolled online.

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 objectives of the Certificate are:

1. Apply the fundamentals of modeling using data including limitations in water resources engineering design and analysis.

21. Approval Process

Departmental Graduate Committee: May 28, 2020
Department: May 29, 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: