



Michigan Technological University

Civil and Environmental Engineering

New Specialty Area for Civil Engineering MS Degree

Intelligent Infrastructure Design

The specialty area encompasses the design of robust, resilient, digitally interconnected civil infrastructure for smart community design. Students will develop holistic design approaches to streamline the incorporation (monitoring, feedback) of all things digital into structures, transportation, geotechnical, water and waste management with a focus on minimizing environmental impact and the advancement in sustainability and resiliency. This is one possible pathway for students to attain an MS in Civil Engineering, while bridging the traditional “silos” identified within the profession.

Specialty Area Description:

The Intelligent Community Design specialty area is intended to offer training for applying technology to make our communities work more sustainably and efficiently. The pathway consists of courses that provide necessary knowledge of the engineering design and analysis of infrastructure systems (e.g., transportation, water resources/environmental, structural, and geotechnical), data collection techniques (from traditional surveying to more advanced sensor and sensing techniques), and computing (machine learning, optimization, numerical simulation, and big data as it relates to infrastructure/geospatial information). Graduates of this specialty area will be able to meet emerging and rapidly-growing needs for engineers to build more intelligent communities.

Coursework:

The following breakdown of courses is meant to serve as a guide when crafting a degree schedule for students interested in focusing on Intelligent Community Design. Potential courses are provided below; however, alternative courses could be selected based on the student's interests, goals and prior education. Consultation with a faculty advisor is required.

- a) **4-5 core courses** that provide a foundation for designing different civil engineering infrastructure systems with a focus on the environment and sustainability. Courses should be selected to provide adequate breadth across the areas of civil/environmental engineering, while also providing sufficient coursework focused on design vs. systems thinking.

Structures:

CEE 4244 Loads for Civil Structures
CEE 5730 Probabilistic Analysis and Reliability

Water Resources:

CEE 4507 Water Distribution and Wastewater Collection Design
CEE 4640/5640 Stormwater Management and Low Impact Development
CEE 5630 Advanced Hydrology

CEE 5666 Water Resources Planning and Management

Environmental:

CEE 4502 Wastewater Treatment Principles and Design
CEE 4503 Drinking Water Treatment Principles and Design
CEE 4503 Air Quality Engineering and Science
CEE 4506 Sustainable Engineering
CEE 5501 Environmental Process Engineering
CEE 5502 Biological Treatment Processes
CEE 5503 Physical-Chemical Treatment Processes
CEE 4505/5505 Surface Water Quality Engineering

Transportation:

CEE 4020 Computer Applications: Visualizing and Communicating Design Information
CEE 5190 Sustainable Pavements
CEE 5401 Advanced Pavement Design
CEE 5402 Traffic Flow Theory
CEE 5404 Transportation Planning
CEE 5417 Transportation Design

Geotechnical:

CEE 4820 Foundation Engineering
CEE 4830 Geosynthetics Engineering
CEE 5810 Advanced Soil Mechanics
CEE 5811 Fundamentals of Soil Behavior and Engineering Laboratory

b) **3 courses** should be selected to provide necessary computing skills.

i. Machine Learning

CS 4811 Artificial Intelligence
CS 5811 Advanced Artificial Intelligence
EE 5841 Machine Learning
GE 5950 Applied Remote Sensing and Machine Learning
UN 5550 Introduction to Data Science

ii. Database and Data Structures

CS 2321 Data Structures
CS 3425 Intro to Database Systems
CS 4321 Introduction to Algorithms
CS 5321 Advanced Algorithms

iii. Optimization

CEE 5760 Optimization Methods in Civil and Environmental Engineering
MA 5630 Numerical Optimization

- iv. Computer Simulation
 - CEE 5710 Modeling and Simulation Applications for Decision Making in Complex Dynamic Systems
 - CEE 5740 Introduction to System Identification
 - CEE 5870 Multiphysics of Porous Materials

- v. Regression/Data Mining
 - EC 4200 Econometrics
 - FW 5412 Regression in R
 - MA 4710 Regression Analysis

c) **1-2 courses related to data acquisition**

- FW 4540 Remote Sensing of the Environment
- GE 4250 Fundamentals of Remote Sensing
- SU 5010 Geospatial Concepts, Technologies, and Data
- SU 5011 Cadaster and Land Information Systems
- SU 5012 Geospatial Data Mining and Crowdsourcing
- SU 5013 Hydrographic Mapping and Surveying
- SU 5142 3D Surveying and Modeling with Laser Scanner Data
- SU 5300 Geospatial Monitoring of Engineering Structures and Geodynamic Processes
- SU 5540 Advanced Photogrammetry – Satellite Photogrammetry
- SU 5541 Close-Range Photogrammetry

d) **1 course for coding:**

- SAT 5002 Application Programming Introduction
- SU 5601 R for Geoinformatics

Note that selected courses would have to adhere to basic requirements of the Civil MS program. Namely, a minimum of 15 credits must be taken within the CEE Department. In addition, students must take one of the following courses: CEE 5710, CEE 5730, CEE 5740, or CEE 5760. A minimum of 18 5000-level credits must be taken; a maximum of 12 3000- or 4000-level courses can be used towards the 30 credit requirement. All MSCE degree requirements and rules set forth by the Department and the Graduate School must be met in order for a student to finish the program.