

GUIDELINES FOR M.S.E. DEGREE IN CIVIL ENGINEERING: CONCENTRATION IN INTELLIGENT SYSTEMS ENGINEERING

Introduction

It is becoming increasingly common for civil infrastructures and environmental systems to incorporate intelligent and autonomous subsystems. Examples include decision systems, feedback control, and advanced artificial intelligence, as well as sensor and actuation networks. These technologies can be utilized to make infrastructures more responsive to uncertain and dynamically-changing environments and loads, thus enhancing their resilience and reliability. They can also be used to enable real-time, automated adaptation and reconfiguration of infrastructures, for the purpose of enhancing their efficiency and sustainability. Cultivation of an expertise in this area requires exposure to many concepts from Systems Engineering (e.g., dynamical systems, control theory, sensing and signal processing, and optimization theory), which historically have not been part of a traditional Civil Engineering curriculum. CE Students who specialize in Intelligent Systems Engineering pursue a rigorous curriculum of systems engineering courses. However, they also complete coursework a practice-oriented sub-discipline within Civil Engineering (e.g., Structures, Hydrology, Transportation, etc.) and must conduct a research project in this area, which applies concepts and technologies from systems engineering.

General

An applicant for the M.S.E. degree should present the equivalent of an undergraduate engineering program as preparation. More specifically, it is expected that applicants will have successfully completed the following courses in their undergraduate preparation:

- Physics 140 (mechanics) and 240 (electricity and magnetism) or equivalents
- Mathematics 215 (multivariable calculus) and 216 (differential equations) or equivalents
- CEE 373 (probability and statistical methods) or equivalent
- CEE 303 (computational methods) or equivalent

If an admitted applicant has not completed these courses, then some additional undergraduate coursework may be required to be completed (without credit) to complete the M.S.E. degree in Civil Engineering with a concentration in Intelligent Systems. In such situations, the specific additional courses to be completed will be determined by the Masters Advisor for the Intelligent Systems specialization.

Coursework

A student pursuing an M.S.E. degree in Civil Engineering with a concentration in Intelligent Systems Engineering must complete at least 30 credit hours of acceptable graduate work. A thesis is not required for the M.S.E. degree. In satisfying the credit hour requirement, the following requirements must be satisfied:

- To be defined as proficient in infrastructure systems, a student must successfully complete the following four core systems courses to constitute the system theory/engineering core:
 - CEE572: Dynamics Infrastructure Systems
 - CEE575: Sensing for Civil Infrastructure Systems
 - CEE571: Linear System Theory
 - CEE553: Infrastructure Systems Optimization –OR- IOE510: Linear Programming
- The student is required to elect two more courses from the following “core plus” set of courses to further their foundation in system theory/engineering:
 - EECS460: Control Systems Analysis and Design
 - EECS 501: Prob. and Random Processes -OR- CEE573: Data Analysis in Civil and Env. Engineering
 - EECS 502: Stochastic Processes -OR- CEE576: Stochastic Systems
 - EECS 550: Information Theory
 - EECS 551: Matrix Methods for Signal Processing, Data Analysis and Machine Learning
 - EECS 564: Estimation, Filtering, and Detection
 - EECS 565: Linear Feedback Control Systems
- With the guidance and approval of a systems-area faculty member, a student must plan their program of study so as to establish a more advanced level of proficiency in an application area of their choice (e.g., structural, hydraulics, energy, transportation, etc.) within CEE.
- At least 18 of the credit hours must be in Civil and Environmental Engineering (CEE) courses.
- The student is required to complete 2 credits of independent study (CEE 970), in their application area of choice.
- No more than 12 credit hours at the 400 level listed in the bulletin of the Rackham School of Graduate

Studies are acceptable. Of these 12 hours, a maximum of 9 hours can be in CEE courses.

- SUGS students with undergraduate specialization in any area of CEE may pursue an M.S.E. degree in Civil Engineering with a concentration in Intelligent Systems. SUGS students are permitted to double count up to 6 credit hours.
- A maximum of 6 graduate level semester hours (with a grade of B or better) can be transferred from other institutions approved by Rackham.
- Table 1 provides students with guidance on courses (both CEE and cognate courses) pertinent to the concentration in Intelligent Infrastructure Systems.

Grades

The grading system used for graduate studies is based on the following 9-point scale:

A+ = 4.3; A = 4.0; A- = 3.7; B+ = 3.3; B = 3; B- = 2.7; C+ = 2.3; C = 2; C- = 1.7

A minimum cumulative graduate grade point average (GPA) of 3 on this 4.0-point scale is required for all graduate courses taken for credit and applied toward the Master's Degree.

Diploma

To be considered for a master's degree diploma, a student must submit a formal application to the Office of Graduate Academic Records of the Graduate School. The deadline for the Graduate School to receive the degree application form is four weeks after the first day of classes in a full term and one week after the first day of classes in a half term. These dates can usually be found on the Rackham Graduate School web site (<http://www.rackham.umich.edu/>).

Additional Information:

For additional information on M.S.E. degree requirements, see the *Graduate Student Handbook* (prepared by the Horace H. Rackham School of Graduate Studies) and the CEE Department Guidelines. The *Graduate Student Handbook* is available on the World Wide Web at <http://www.rackham.umich.edu/>.

Table 1: Example Course Sequences for ISE Students to Follow:

Degree Req.	Structures	Hydraulics	Energy	Transportation
Systems Core (13 credits)	CEE571: Linear Systems			
	CEE572: Dynamics Infrastructure Systems			
	CEE 553: Infrastructure Sys Optimization			
	CEE575: Sensing for Civil Infrastructure			
Core Plus (6 credits)	CEE576: Stochastic Systems	EECS 551. Matrix Methods for Signal Processing, Data Analysis and Machine Learning	CEE576: Stochastic Systems	EECS 551. Matrix Methods for Signal Processing, Data Analysis and Machine Learning
	EECS460: Control Systems Analysis and Design	EECS 564. Estimation, Filtering, and Detection	EECS 565: Linear Feedback Control Systems	EECS 501: Probability and Random Processes
Concentration Electives (9 credits)	CEE511: Structural Dynamics	CEE521: Flow in Open Channels	CEE 567: Energy Infrastructure Systems	CEE 551: Traffic Science
	CEE510: FEM in Solid & Structural Mech	CEE 520: Physical Processes of Land-Surface Hydrology	EECS 463: Power Systems Design and Operation	CEE 552: Transportation Network Modeling
	CEE 512: Nonlinear Analysis of Structures	CEE 526: Design of Hydraulic Systems	EECS 598: Power Systems Markets and Optimization	CEE554: Data Mining in Transportation
Research (2 credits)	CEE 970: Independent Study	CEE 970: Independent Study	CEE 970: Independent Study	CEE 970: Independent Study

Concentration in Intelligent Systems Engineering: WORKSHEET

Student Name: _____ Faculty Advisor: _____

STEP 1: Identify Specialization Area of CEE:

Select your area of disciplinary specialization.

- | | | | |
|---------------------------------------|--|---|---------------------------------------|
| <input type="checkbox"/> Structures | <input type="checkbox"/> Materials | <input type="checkbox"/> Hydraulics | <input type="checkbox"/> Geotechnical |
| <input type="checkbox"/> Construction | <input type="checkbox"/> Environmental | <input type="checkbox"/> Transportation | <input type="checkbox"/> Energy |

STEP 2: Core Systems Courses:

All courses must be taken.

Core Course	Term Taken	CEE Credits	Non-CEE Credits*
CEE572			
CEE575			
CEE571			
CEE553 -OR- IOE510			
TOTAL			

STEP 3: Core Plus System Courses:

Please select courses taken or to be taken (select 2).

Core Course	Term Taken	CEE Credits	Non-CEE Credits*
EECS 460			
EECS 501 -OR- CEE 573			
EECS 502 -OR- CEE 576			
EECS 550			
EECS 551			
EECS 564			
EECS 565			
TOTAL			

STEP 3: Other Courses:

Please identify other courses taken. Directed studies, seminar or independent research credits are not acceptable to satisfy course requirements.

Non-core Course	400-Level (Yes/No)	Term Taken	CEE Credits	Non-CEE Credits*
TOTAL				

STEP 4: Research Project:

Please provide details on your Independent Study research project.

Research Project Title	Term Taken	CEE Credits	Non-CEE Credits*
CEE970 (Title: _____)			
TOTAL			

STEP 5: Program Requirements:

Check to ensure all other program requirements have been met.

Requirement	Credits	Limit
Total Number of Credits Taken		≥ 30
Number of CEE Credits Taken (incl. CEE 970)		≥ 18
Total Number of 400-Level Credits		≤ 12
Total Number of 400-Level Credits in CEE		≤ 9

Advisor signature _____

Date: _____