

University of Michigan
Engineering Sustainable Systems
Sustainable Water Systems specialization

Dual-Master's Degree Program
 Summary of Requirements for a Master of Science
(Sustainable Systems) and a Master of Science in Engineering
(Environmental Engineering)

Effective Fall 2014

2 Year MS & MSE Plan		Requirement*	Notes	Course #	Credits	Term	
Engineering	Environmental Engineering Core	18CR from the Civil and Environmental Engineering Department	Required: CEE 581 CEE 582 CEE 591 CEE 881 (1 st Fall in program)	CEE 881			
				CEE 581			
				CEE 582			
				CEE 591			
		12CR from within one of the following Environmental Engineering Majors: (courses on next page)	Choose one: A) Ecohydrology B) Water Quality Process Engineering C) Water Quality and Resources Engineering				
		3CR of approved Mathematics	See Env. Eng. dept. requirements and Cognates (3 rd page)				
Natural Resources and Environment	SS CORE	6CR in Systems Analysis for Sustainability	Required: NRE 557/CEE 586 And one course from List A1 (3 rd page)	NRE 557			
		9CR total	Sustainable Design & Technology Minimum 3CR	Required: See List A2 for acceptable courses (3 rd page)			
			Sustainable Enterprise Minimum 3CR	See List A3 for acceptable courses (3 rd page)			
			Additional 3CR minimum from list A1, 2, or 3	See attached list (A1-3) of acceptable courses in these specializations			
	NRE Core	NRE 509 NRE 510					
		IAMS Requirement Two courses; 3CR minimum Please see page 3 for approved courses					
	Analytics	3CR in Analytics	NRE 538 or equivalent required:				
Opus*	Students <u>are not</u> expected to complete an Opus, but could petition to do a thesis/practicum or project*	At most 6CR of NRE 700/701					
Cognates <i>/Rackham</i>		Please see 3 rd page for cognate requirement information					
TOTALS	MINIMUM CREDIT HOURS BY SCHOOL	"NRE" – Minimum 25CR					
	TOTAL CREDIT HOURS	"CEE" – Minimum 18CR	Minimum 54 Credit Hours				

*Any waiver or substitution of degree requirement must be approved by the appropriate faculty and submitted to OAP

Environmental Engineering

A) Ecohydrology

Choose four:

- CEE 428 – Introduction to Groundwater Hydrology
- CEE 520 – Deterministic & Stochastic Models in Hydrology
- CEE 521 – Open Channel Flow
- CEE 522 – Sediment Transport
- CEE 524 – Environmental Turbulence

or

- CEE 525 – Turbulent Mixing in Buoyant Flows
- CEE 527 – Coastal Hydraulics
- CEE 590 – Stream, Lake, and Estuary Analysis
- CEE 593 – Environmental Soil Physics
- CEE 624 – Restoration Fundamentals & Practice in Aquatic Systems

B) Water Quality Process Engineering

Required:

- CEE 580 – Physical Chemical Processes in Environmental Engineering
- CEE 592 – Biological Processes in Environmental Engineering

Choose two:

- CEE 428 – Introduction to Groundwater Hydrology
- CEE 583 – Surface & Interfaces in Aquatic Systems
- CEE 593 – Environmental Soil Physics
- CEE 594 – Environmental Soil Chemistry
- CEE 693 – Environmental Molecular Biology
- Approved CHEM or BIOLCHEM or ChE or AOSS elective

Choose at least one:

- CEE 521 – Open Channel Flow
- CEE 522 – Sediment Transport

Choose at least one:

- CEE 580 – Physical Chemical Processes in Environmental Engineering
- CEE 592 – Biological Processes in Environmental Engineering

Choose up to two (only one of CEE 524 or CEE 525 may be taken):

- CEE 428 – Introduction to Groundwater Hydrology
- CEE 520 – Deterministic and Stochastic Models in Hydrology
- CEE 524 – Environmental Turbulence

or

- CEE 525 – Turbulent Mixing in Bouyant Flows
- CEE 526 – Design of Hydraulic Systems
- CEE 624 – Restoration Fundamentals & Practice in Aquatic Systems

Natural Resources and Environment

A) Sustainable Systems Core (1-3)

1) Systems Analysis for Sustainability (at least 6CR*)

NRE 573 (3cr) Environmental Footprinting & Environmental Input-Output Analysis (W)

NRE 610 (1.5cr)

NRE 597 (3cr) Environmental Systems Analysis (F)

NRE 557/CEE 586 (3cr) Industrial Ecology (W)

NRE 550/STRAT 566 (3cr) Systems Thinking for Sustainable Development (W)

*At least two courses need to be from the courses listed above

NRE 570 (3cr) Environ Economics: Quantitative Methods & Tools (F)

NRE 501 (1.5cr) Five courses on selected topics in Env. Economics (FA B & WN A&B)

NRE 531 (4cr) Principles of GIS (W)

2) Sustainable Design & Technology (3CR)

NRE 5373cr) Urban Sustainability (F)

NRE 615 (3cr) Renewable Electricity and the Grid (W)

NRE 574/PUBPOL 519 (3cr) Sustainable Energy Systems (F)

NRE 548 (3cr) Land Use and Global Change (F)

NRE 605/BA 605 (3cr) Green Development (W)

NRE 687 (4cr) Landscape Planning (F)

ARCH 575 (3cr) Building Ecology (F)

CEE 460 (3cr)
CEE 582 (3cr)
CEE 686/ChE 686 (2-3cr)
MECHENG 589 (3cr)
DESCI 502 (3)
DESCI 790 (1-4)
EECS 498 (3)

3) Sustainable Enterprise (3CR)

NRE 501.159 (3cr)
NRE 512/LHC 536 (2.25cr)
NRE 513/STRAT 564&564 (3cr)
NRE 527/BE 527 (3cr)
NRE 532 (3cr)
NRE 533 (3cr)
BE 555 (1.5)
NRE 560/UP 560 (3cr)
ENGR 521 (3cr)
NRE 501.114/CEE 686/ChE 686(3cr)
FIN 637 (2.25cr)
STRAT 735-739 (1.5cr)
FIN 583 (1.5cr)

Design of Environ Engineering Systems (F)
Environmental Microbiology (F)
Case Studies in Environ Sustainability (W)
Sustainable Design of Technology Systems (F)
Design Process Models (W)
Design Science Colloquium (F or W)
Grid Integration of Alternative Energy Sources (TBD)

Decision Making for Sustainability (W)
Ethics Corporate Management (F or W)
Strategies for Sustainable Development (F)
Energy Markets and Energy Politics (F)
Natural Resources and Environ Conflict Management (F)
Negotiation Skills (F)
Non Market Strategy (F)
Behavior and Environment (F)
CleanTech Entrepreneurship (F)
Environmental Finance (F)
Finance and Sustainable Enterprises (F)
Topics in Global Sustainable Enterprise (F)
Energy Project Finance (W)

B) Sustainable Systems Electives

B1) Additional SS courses (can count towards Non-Opus option)

NRE 514 (2cr)
NRE 523(3cr)
EHS 672 (3cr)
NRE 552
NRE 686/PUBPOL 563 (3cr)
BA 612 (2.25cr)
ESENG 501 (3cr)
Econ 437 (3cr)
UP 533/ARCH 506 (3cr)

Environmental Impact Assessment (F)
Environmental Risk Assessment (W)
Life Cycle Assessment: Human Health & Environ Impacts (F)
Ecosystem Services (F)
Environmental Policy (W)
Strategies for the Base of the Pyramid (F)
Seminars in Energy Science, Technology, and Policy (F)
Energy Economics & Policy (W)
Sustainable Urbanism and Architecture (F)

B2) Sustainable Systems Themes (see links for course listings):

Energy Systems - <http://www.snre.umich.edu/node/7746/#energy>
Mobility Systems - <http://www.snre.umich.edu/node/7746/#transportation>
Water Systems - <http://www.snre.umich.edu/node/7746/#water>
Food Systems - <http://www.snre.umich.edu/node/7746/#foode>.

Integrated Analytic Methods and Skills Requirement

Students are required, at some point during their time enrolled in the program, to take 2 courses composing at least 3 credits from a faculty-approved list of courses that focus on integrative analytic methods and skills. The faculty-approved existing courses that satisfy this requirement are listed below:

Fall

501 – Social Vulnerability & Adaptation to Environ Change
578 – Urban Stormwater
552 – Ecosystem Services
514 – Environmental Impact Assessment
533 – Negotiation Skills (Fall A)
536 – Mediation Skills
548 – Land Use and Global Change
570 – Environmental Economics
597 – Environmental Systems Analysis
564 – Localization Seminar
677 – Climate Adaptation Seminar
687 – Landscape Planning

Winter

501 – Stakeholder Network Analysis

501 – Science and Management of the Great Lakes
501 - Decision Making for Sustainability
532 – Natural Resource Conflict Management
545- Applied Ecosystem Modeling
550 – Systems Thinking for Sustainable Development
557 – Industrial Ecology
581 – Advanced Environmental Education
589 – Ecological Restoration
610 – Advanced LCA Methods and Software Tools
641 – Interdisciplinary Research Methods
787 – Metro Studio (MLA only)