**University of Michigan**  
**Engineering Sustainable Systems**  
*Sustainable Water Systems specialization*

Effective Fall 2014

<table>
<thead>
<tr>
<th>Requirement*</th>
<th>Notes</th>
<th>Course #</th>
<th>Credits</th>
<th>Term</th>
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</thead>
<tbody>
<tr>
<td>18CR from the Civil and Environmental Engineering Department</td>
<td>Required: CEE 881, CEE 581, CEE 582, CEE 591, CEE 881 (1st Fall in program)</td>
<td>CEE 881</td>
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<tr>
<td>12CR from within one of the following Environmental Engineering Majors: (courses on next page)</td>
<td>Choose one: A) Ecophydrology, B) Water Quality Process Engineering, C) Water Quality and Resources Engineering</td>
<td>CEE 581</td>
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<tr>
<td>3CR of approved Mathematics</td>
<td>See Env. Eng. dept. requirements and Cognates (3rd page)</td>
<td>CEE 591</td>
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<tr>
<td>6CR in Systems Analysis for Sustainability</td>
<td>Required: NRE 557/CEE 586 and one course from List A1 (3rd page)</td>
<td>NRE 557</td>
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<tr>
<td>Sustainable Design &amp; Technology Minimum 3CR</td>
<td>Required: See List A2 for acceptable courses (3rd page)</td>
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<tr>
<td>Sustainable Enterprise Minimum 3CR</td>
<td>See List A3 for acceptable courses (3rd page)</td>
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<tr>
<td>Additional 3CR minimum from list A1, 2, or 3</td>
<td>See attached list (A1-3) of acceptable courses in these specializations</td>
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<td>NRE 509</td>
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<td>NRE 510</td>
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<tr>
<td>IAMS Requirement Two courses; 3CR minimum Please see page 3 for approved courses</td>
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<td>3CR in Analytics</td>
<td>NRE 538 or equivalent required:</td>
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<td>Students are not expected to complete an Opus, but could petition to do a thesis/practicum or project*</td>
<td>At most 6CR of NRE 700/701</td>
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<td>Please see 3rd page for cognate requirement information</td>
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<tr>
<td>Minimum Credit Hours by School</td>
<td>“NRE” – Minimum 25CR</td>
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<td>“CEE” – Minimum 18CR</td>
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<tr>
<td>TOTALS</td>
<td>Minimum 54 Credit Hours</td>
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*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 537 (3cr) 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)

Last Revised 05/31/2016
CEE 460 (3cr)  
CEE 582 (3cr)  
CEE 686/ChE 686 (2-3cr)  
MECHENG 589 (3cr)  
DESCI 502 (3)  
DESCI 790 (1-4)  
ECE 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)  

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)  
ESEN 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/#food  

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)