### Engineering Sustainable Systems
*Sustainable Energy Systems specialization*

**Effective Fall 2014**

<table>
<thead>
<tr>
<th>2-2.5 Year MS &amp; MSE Plan</th>
<th>Requirement</th>
<th>Notes</th>
<th>Course #</th>
<th>Credits</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engineering</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Environmental Engineering Core | 18CR in CEE courses at the 500 or 600 level  
6CR in additional CEE courses | Required:  
CEE 581  
CEE 582  
CEE 591  
CEE 881 (1st Fall in program)  
And one course from List A (next page) | CEE 581  
CEE 582  
CEE 591  
CEE 881  
CEE 880 |
| **Sustainable Energy Systems Major** | 12CR from the “Sustainable Energy Systems” Major | CEE 567 and 9CR from List A (see next page) | CEE 567 |
| **Advanced Math Requirement** | 3CR in approved Mathematics or equivalent | See Env. Eng dept. requirements and Cognates (next page) | |
| **SS Core**              |             |       |          |         |      |
|                         | 6CR in Systems Analysis for Sustainability | Required:  
NRE 557/CEE 586  
And one course from List 1 (next page) | CEE 586 |
|                         | Sustainable Design & Technology  
Minimum. 3CR | Required: NRE 574  
See List 2 for other acceptable courses (next page) | NRE 574 |
|                         | Sustainable Enterprise  
Minimum 3CR | See List 3 for acceptable courses (next page) | |
|                         | Additional 3CR minimum from list A1, 2, or 3 | See attached list (A1-3) of acceptable courses in these specializations | |
| **Natural Resources and Environment** | | | | |
| NRE Core | NRE 509  
NRE 510  
IAMS Requirement  
Two courses; 3CR minimum  
Please see page 3 for approved courses. | | |
| Analytics | One statistics course | NRE 538 or equivalent required | |
| Opus | Master’s Project/Thesis/Practicum | At most 6CR of NRE 700/701 | |
| Cognates | Rackham requirement | Please see next page for cognate requirement information | |
| **TOTALS** | | | | |
| Total Credit Hours by School | “NRE” - Minimum 25CR  
“CEE” - Minimum 18CR | | |
| Total Credit Hours | Minimum 54 Credit Hours | | |

**For More Information:**

- Please see the Rackham advising and registration website for academic requirements information.
- Dual-Master’s Degree Program
- Summary of Requirements for a Master of Science (Sustainable Systems) and a Master of Science in Engineering (Environmental Engineering)

**Last Revised 05/31/2016**
### A) Sustainable Energy Systems (12CR total)

**Required:**
- CEE 567 (3)  
  Energy Infrastructure Systems (W)
- Civil and Environmental Engineering (choose one):
  - CEE 526 (3)  
    Design of Hydraulic Systems (W)
  - CEE 549 (3)  
    Geoenvironmental Engineering (F)
  - CEE 592 (3)  
    Biological Processes in Environ Eng (W)
- Energy Electives (choose two):
  - CHE 548 (3)  
    Electrochemical Engineering (F)
  - CHE 568 (3)  
    Fuel Cells and Fuel Processors (F)
  - EECS 463 (4)  
    Power Systems Des & Operations (F)
  - EECS 498 (4)  
    Grid Integrations of Alt Energy Sources (W)
  - ME 432 (3)  
    Combustion (W)
  - ME 433 (3)  
    Advanced Energy Solutions (F,W)
  - ME 571 (3)  
    Energy Generation and Storage (F)
  - ME 589 (3)  
    Sustainable Des of Technology Systems (F)
  - NERS 531 (3)  
    Nuclear Waste Management (W)

### A) Sustainable Systems Core (1-3)

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRE 573</td>
<td>Environmental Footprinting and Environmental Input-Output Analysis (W)</td>
</tr>
<tr>
<td>NRE 610</td>
<td>Advanced LCA Methods &amp; Software Tools (W)</td>
</tr>
<tr>
<td>NRE 597</td>
<td>Environmental Systems Analysis (F)</td>
</tr>
<tr>
<td>NRE 557/CEE 586</td>
<td>Industrial Ecology (W)</td>
</tr>
<tr>
<td>NRE 550/STRAT 566</td>
<td>Systems Thinking for Sustainable Development (W)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRE 570 (3cr)</td>
<td>Environ Economics: Quantitative Methods &amp; Tools (F)</td>
</tr>
<tr>
<td>NRE 501 (1.5cr)</td>
<td>Five courses on selected topics in Env. Economics (FA B &amp; WN A&amp;B)</td>
</tr>
<tr>
<td>NRE 531 (4cr)</td>
<td>Principles of GIS (F&amp;W)</td>
</tr>
</tbody>
</table>

2) **Sustainable Design & Technology (3CR)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRE 537 (3CR)</td>
<td>Urban Sustainability (F)</td>
</tr>
<tr>
<td>NRE 501.087 (3CR)</td>
<td>Technology and Community Sustainable Development (W)</td>
</tr>
<tr>
<td>NRE 615 (3CR)</td>
<td>Renewable Electricity and the Grid (W)</td>
</tr>
<tr>
<td>NRE 574/PUBPOL 519 (3cr)</td>
<td>Sustainable Energy Systems (F)</td>
</tr>
<tr>
<td>NRE 548 (3cr)</td>
<td>Land Use and Global Change (F – every other year)</td>
</tr>
<tr>
<td>NRE 605/BA 605 (3cr)</td>
<td>Green Development (W)</td>
</tr>
<tr>
<td>NRE 687 (4cr)</td>
<td>Landscape Planning (F)</td>
</tr>
<tr>
<td>ARCH 575 (3cr)</td>
<td>Building Ecology (F)</td>
</tr>
<tr>
<td>CEE 480 (3cr)</td>
<td>Design of Environ Engineering Systems (F)</td>
</tr>
<tr>
<td>CEE 582 (3cr)</td>
<td>Environmental Microbiology (F)</td>
</tr>
<tr>
<td>MECHENG 589 (3cr)</td>
<td>Sustainable Design of Technology Systems (W)</td>
</tr>
</tbody>
</table>

3) **Sustainable Enterprise (3CR)**
NRE 501.159 (3cr)          Decision Making for Sustainability (W)
NRE 512/B2 536 (2.25cr)     Ethics Corporate Management (F or W)
NRE 513/STRAT 564&565 (3cr)  Strategies for Sustainable Development (F)
NRE 527/BE 527 (3cr)        Energy Markets and Energy Politics (F)
NRE 532 (3cr)               Natural Resources and Environ Conflict Management (F)
NRE 533 (3cr)               Negotiation Skills (W)
BE 555 (1.5)                Non Market Strategy (F)
NRE 560/UP 560 (3cr)        Behavior and Environment (F)
NRE 501.014/CEE 686/ChE 686 (3cr) Environmental Finance (F)
ENGR 521 (3cr)              CleanTech Entrepreneurship (W)
FIN 637 (2.25cr)            Finance and Sustainable Enterprises (F)
STRAT 735-739 (1.5cr)       Topics in Global Sustainable Enterprise (F)
FINANCE 583 (1.5cr)         Energy Project Finance (W)

B) Sustainable Systems Electives

B1) Additional SS courses (can count towards Non-Opus option)
NRE 514 (2cr)               Environmental Impact Assessment (F)
NRE 523 (3cr)               Environmental Risk Assessment (W)
NRE 552 (3cr)               Ecosystem Services (F)
EHS 672 (3cr)               Life Cycle Assessment: Human Health & Environ Impacts (F)
NRE 686/PUBPOL 563 (3cr)    Environmental Policy (W)
BA 612 (2.25cr)             Strategies for the Base of the Pyramid (F)
ESENG 501 (3cr)             Seminars in Energy Science, Technology, and Policy (F)
Econ 437 (3cr)              Energy Economics & Policy (W)
UP 533/ARCH 506 (3cr)       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
Built Environment - http://www.snre.umich.edu/node/7746/#builtenv
Climate Change - http://www.snre.umich.edu/node/7746/#climchange

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)