<table>
<thead>
<tr>
<th>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>Engineering</td>
<td><strong>Mechanical Engineering Core</strong></td>
<td>12CR in ME courses at the 500 or 600 level</td>
<td>ME 589</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Required Courses: ME 589 At least one course from Mechanical Engineering course list (next page)</td>
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<tr>
<td></td>
<td></td>
<td><strong>6CR in additional ME courses or research at 400 level or above</strong></td>
<td>ME 455</td>
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<td></td>
<td></td>
<td>*ME option: • Coursework Only</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td><strong>6CR in acceptable Mathematics or equivalent</strong></td>
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<td></td>
<td></td>
<td>Please see: ME Graduate Handbook</td>
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<tr>
<td>SS Core</td>
<td></td>
<td>6CR in Systems Analysis for Sustainability</td>
<td>NRE 557</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Required Course: NRE 557 / CEE 586 And one course from List A1 (next page)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td><strong>9CR total</strong></td>
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<td></td>
<td></td>
<td>Sustainable Design &amp; Technology Minimum 3CR</td>
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<td></td>
<td></td>
<td>See List A2 for acceptable courses (next page)</td>
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<td></td>
<td>Sustainable Enterprise Minimum 3CR</td>
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<td></td>
<td></td>
<td>See List A3 for acceptable courses (next page)</td>
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<td></td>
<td></td>
<td>Additional 3CR minimum from list A1, 2, or 3 See attached list (A1-3) of acceptable courses in these specializations</td>
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<tr>
<td>Natural Resources and Environment</td>
<td></td>
<td>NRE Core</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>NRE 509 NRE 510</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>IAMS Requirement Two courses; 3CR minimum Please see page 3 for approved</td>
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<tr>
<td>Analytics</td>
<td></td>
<td>3CR in Analytics</td>
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<tr>
<td></td>
<td></td>
<td>NRE 538 or equivalent required</td>
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</tr>
<tr>
<td>Opus</td>
<td></td>
<td>Master’s Project/Thesis/Practicum At most 6CR of NRE 700/701</td>
<td></td>
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</tr>
<tr>
<td>Cognates</td>
<td></td>
<td>Minimum 4 credit hours outside of degree program Likely fulfilled by other crosslisted courses</td>
<td></td>
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<tr>
<td>[Rackham requirement]</td>
<td></td>
<td>Minimum CREDIT HOURS BY SCHOOL</td>
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<tr>
<td></td>
<td></td>
<td>“NRE” - Minimum 25CR</td>
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<td></td>
<td></td>
<td>“ME” - Minimum 18CR</td>
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<tr>
<td>TOTALS</td>
<td></td>
<td>TOTAL CREDIT HOURS Minimum 54 Credit Hours</td>
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</tr>
</tbody>
</table>

*Please see the Mechanical Engineering Student Services Office if you would prefer to complete their Research or Thesis option.

05/31/2016 Last Revised
### Sustainable Engineering Certificate Program

#### 1) Systems Analysis for Sustainability (at least 6 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRE 573 (3cr)</td>
<td>Environ Footprinting &amp; Environmental Input-Output Analysis (W)</td>
</tr>
<tr>
<td>NRE 610 (1.5cr)</td>
<td>Advanced LCA Methods &amp; Software Tools (W)</td>
</tr>
<tr>
<td>NRE 597 (3cr)</td>
<td>Environmental Systems Analysis (F)</td>
</tr>
<tr>
<td>NRE 557/CEE 586 (3cr)</td>
<td>Industrial Ecology (W)</td>
</tr>
<tr>
<td>NRE 550/STRAT 566 (3cr)</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 (TBD)</td>
</tr>
<tr>
<td>NRE 531 (4cr)</td>
<td>Principles of GIS (F&amp;W)</td>
</tr>
</tbody>
</table>

#### 2) Sustainable Design & Technology (3 credits)

<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 Energy 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)</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 460 (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>CEE 686/CE 686 (2-3cr)</td>
<td>Case Studies in Environ Sustainability (W)</td>
</tr>
<tr>
<td>MECHENG 589 (3cr)</td>
<td>Sustainable Design of Technology Systems (F)</td>
</tr>
<tr>
<td>DESC 502 (3)</td>
<td>Design Process Models (W)</td>
</tr>
<tr>
<td>DESC 790 (1-4)</td>
<td>Design Science Colloquium (F or W)</td>
</tr>
<tr>
<td>EEC5 498 (3)</td>
<td>Grid Integration of Alternative Energy Sources (TBD)</td>
</tr>
</tbody>
</table>

#### 3) Sustainable Enterprise (3 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRE 501.159 (3cr)</td>
<td>Decision Making for Sustainability (W)</td>
</tr>
<tr>
<td>NRE 512/LHC 536 (2.25)</td>
<td>Ethics Corporate Management (F or W)</td>
</tr>
<tr>
<td>NRE 513/STRAT 564/564 (3cr)</td>
<td>Strategies for Sustainable Development (F)</td>
</tr>
<tr>
<td>NRE 527/BE 527 (3cr)</td>
<td>Energy Markets and Energy Politics (F)</td>
</tr>
<tr>
<td>NRE 532 (3cr)</td>
<td>Natural Resources and Environ Conflict Management</td>
</tr>
<tr>
<td>NRE 533 (3cr)</td>
<td>Negotiation Skills (F)</td>
</tr>
<tr>
<td>BE 555 (1.5)</td>
<td>Non Market Strategy (F)</td>
</tr>
<tr>
<td>NRE 560/UP 560 (3cr)</td>
<td>Behavior and Environment (F)</td>
</tr>
<tr>
<td>ENGR 521 (3cr)</td>
<td>CleanTech Entrepreneurship (F)</td>
</tr>
<tr>
<td>NRES01.014/CEEE86/ChE 686 (3cr)</td>
<td>Environmental Finance</td>
</tr>
<tr>
<td>FIN 637 (2.25cr)</td>
<td>Topics in Global Sustainable Enterprises (F)</td>
</tr>
<tr>
<td>STRAT 735-739 (1.5cr)</td>
<td>Energy Project Finance (W)</td>
</tr>
<tr>
<td>FIN 583 (1.5cr)</td>
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</tr>
</tbody>
</table>

#### B) Sustainable Systems Electives

- Additional 5 credits (can count towards Non-Opus option)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRE 514 (2cr)</td>
<td>Environmental Impact Assessment (F)</td>
</tr>
<tr>
<td>NRE 523 (3cr)</td>
<td>Environmental Risk Assessment (W)</td>
</tr>
<tr>
<td>NRE 552 (3cr)</td>
<td>Ecosystem Services (F)</td>
</tr>
<tr>
<td>EHS 672 (3cr)</td>
<td>Life Cycle Assessment: Human Health &amp; Environ Impacts (F)</td>
</tr>
</tbody>
</table>

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Last Revised
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)