<table>
<thead>
<tr>
<th>Requirement</th>
<th>Notes</th>
<th>Course #</th>
<th>Credits</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering Core</td>
<td>21CR in ChE courses at the 500 level or higher</td>
<td>Required: All courses in Chemical Engineering courses (see next page)</td>
<td>ChE 527</td>
<td>3</td>
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<td>ChE 528</td>
<td>3</td>
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<td>ChE 538</td>
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<td>ChE 542</td>
<td>3</td>
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<td>ChE 595</td>
<td>1</td>
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<td>ChE 505</td>
<td>3</td>
</tr>
<tr>
<td>SS Core [SS-specific requirements]</td>
<td>6CRin Systems Analysis for Sustainability</td>
<td>Required: NRE 557/CEE 586 And one course from List A1 (next page)</td>
<td>NRE 557/CEE 586</td>
<td></td>
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<td></td>
<td></td>
<td>Sustainable Design &amp; Technology Minimum 3CR</td>
<td>Required: NRE 574 See List A2 for other acceptable courses (next page)</td>
<td>NRE 574</td>
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<tr>
<td></td>
<td></td>
<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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<tr>
<td>NRE Core</td>
<td>NRE 509 NRE 510</td>
<td>IAMS Requirement Two courses; 3CR minimum Please see page 3 for approved courses.</td>
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<tr>
<td></td>
<td></td>
<td>10CRin total</td>
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<tr>
<td>Analytics</td>
<td>3CRin Analytics</td>
<td>NRE 538 or equivalent required:</td>
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<tr>
<td>Opus*</td>
<td>Master’s Project/Thesis/Practicum</td>
<td>At most 6CR of NRE 700/701</td>
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<tr>
<td>Cognates</td>
<td></td>
<td>Please see next page for cognate requirement information</td>
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<tr>
<td>TOTALS BY SCHOOL</td>
<td>MINIMUM CREDIT HOURS</td>
<td>“NRE” – Minimum 25CR</td>
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<td></td>
<td>“ChE” – Minimum 21CR</td>
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<tr>
<td>TOTAL CREDIT HOURS</td>
<td>Minimum 54 Credit Hours</td>
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</table>

*Please see the Chemical Engineering Student Services Office if you would prefer to complete their Research or Thesis option instead of the Course Work only option.
Chemical Engineering
ChE 527 (3) Fluid Flow (W)
ChE 528 (3) Chemical Reactor Engineering (F)
ChE 538 (3) Statistical and Irreversible Thermodynamics (W)
ChE 542 (3) Heat and Mass Transport (F)
ChE 595 (1) Chemical Engineering Research Survey (F)

A) Sustainable Systems Core (1-3)

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

- NRE 501.036 (3cr) Consumption, Trade, and Environmental Input-Output Analysis (W)
- 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 (1.5cr) Environ Economics: Quantitative Methods & Tools (WN A)
- 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 501.037 (3cr) Urban Sustainability (F)
- NRE 501.091 (3cr) Renewable Electricity and the Grid (W)
- NRE 574/PUBPOL 519 (3cr) Sustainable Energy Systems (F)
- NRE 501.039 (3cr) Land Use and Global Change (F)
- NRE 576/UP 576 (3cr) Ecological Design Approaches to Brownfield Redevelopment (F)
- NRE 605/BA 605 (3cr) Green Development (W)
- NRE 687 (4cr) Landscape Planning (F)
- ARCH 575 (3cr) Building Ecology (F)
- CEE 460 (3cr) Design of Environ Engineering Systems (F)
- CEE 582 (3cr) Environmental Microbiology (F)
- CEE 686/ChE 686 (2-3cr) Case Studies in Environ Sustainability (W)
- MECHENG 589 (3cr) Sustainable Design of Technology Systems (F)

3) Sustainable Enterprise (3CR)

- NRE 567 (3cr) Transportation Energy & Climate (W)
- NRE 512/LHC 536 (2.25) Ethics Corporate Management (F or W)
- NRE 513/STRAT 564&564 (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 (F)
- BE 555 (1.5) Non Market Strategy (F)
- NRE 560/UP 560 (3cr) Behavior and Environment (F)
- ENGR 521 (3cr) CleanTech Entrepreneurship (F)
- ES 520 (1.5cr) CleanTech Venture Opportunities (F)
- FIN 637 (2.25cr) Finance and Sustainable Enterprises (F)
- FIN 583 (1.5cr) Energy Project Finance (W)
- STRAT 735-739 (1.5cr) Topics in Global Sustainable Enterprise (F)

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)
- EHS 672 (3cr) Life Cycle Assessment: Human Health & Environ Impacts (F)
- NRE 558/CEE 587 (3cr) Water Resource Policy (TBD)
- 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/#bultenv
Climate Change - http://www.snre.umich.edu/node/7746/#climchange

Cognates
SNRE – Minimum 4 credits outside SNRE. Can be fulfilled with ChE coursework.
ChE – Minimum of 2 non-ChE graduate level courses. Can be fulfilled with SNRE coursework.

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 – Land Use and Global Change
501 – Urban Stormwater
501 – Ecosystem Services
514 – Environmental Impact Assessment
533 – Negotiation Skills
536 – Mediation Skills
597 – Environmental Systems Analysis
662 – Localization Seminar
677 – Climate Adaptation Seminar (2nd 7 week)
687 – Landscape Planning

Winter

501 – Science and Management of the Great Lakes
501 – Biofuels and Sustainability
501 – Advanced LCA Methods and Software Tools (W14 – 2nd 7 weeks)
501 - Applied Ecosystem Modeling (W14 – 2nd 7 weeks)
550 – Systems Thinking for Sustainable Development
557 – Industrial Ecology
570 – Environmental Economics
581 – Advanced Environmental Education
589 – Ecological Restoration
641 – Interdisciplinary Research Methods
687 – Landscape Planning
787 – Metro Studio (MLA only)