Interdisciplinary Sustainability Course Module Development for Engineering Programs at Seattle University

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INTRODUCTION

Seattle University defines sustainability as *meeting the needs of present and future generations through actions that support human and ecological health, social justice, and economic well-being*[1].

This project addresses the challenge of comprehensively covering environmental, social, and economic issues in engineering courses. Six interdisciplinary two-person teams, comprised of an engineering faculty member and a non-engineer or industry professional, are tasked with creating course modules that address at least two sustainability dimensions and/or the issue of multi-generational timescales.

- Modules will be informed directly by the Engineering for One Planet (EOP) framework[2]
- Activities will be hosted on a curated website with other sustainability-related resources
- All six courses are scheduled for Winter Quarter 2025, with a total anticipated enrollment of 98 undergraduate students

Table 1: Interdisciplinary teams

Course Title	Team
CEEGR 4880: Engineering Design II	Dr. Nirmala Gnanapragasam, Associate Professor, CEE Dr. Tanya Hayes, Environmental Studies
ECEGR 3120: Semiconductor Devices	Dr. Shiny Abraham, Associate Professor, ECE Dr. Greg Magnan, Professor, Marketing
ECEGR 3500: Electrical Energy Systems	Dr. Shruti Singh, Instructor, ECE Dr. Peter Dauenhauer, Snohomish County PUD
MEGR 4210: Thermodynamics II	Dr. Teodora Rutar Shuman, Professor, ME Dr. Eric Severson, Associate Teaching Professor, Philosophy
MEGR 4880: Engineering Design II	Dr. Yen-Lin Han, Professor, ME Dr. Greg Magnan, Professor, Marketing
SCENG 3030: Humanitarian Engineering	Dr. Mike Marsolek, Associate Professor, CEE Dr. John Armstrong, Assistant Professor, Environmental Studies

SU's COMMITMENT TO SUSTAINABILITY

Seattle University's commitment to lead on sustainability and environmental justice is reinforced by the five-year strategic plan-"Reigniting our Strategic Directions 2022-2027"[3], which includes a multi-year effort to comprehensively reimagine and revise our curriculum. Priorities include:

- Sustainability and Climate Change
- Racial Injustice and Widening Economic Inequity
- Technological Chance and its Impact on Society

Seattle University is committed to participate in the 'Seven-Year Journey Towards Integral Ecology' and the Laudato Si' Action Platform (LSAP)[4].

LSAP Priority 1: Integrate Integral Ecology across the Curriculum and Research
LSAP Priority 2: Achieve Climate Neutrality and Reduce SU's Environmental Footprint
LSAP Priority 3: Practice Socially Responsible Consumption, Purchasing, and Investment
LSAP Priority 4: Develop a Sustainable Campus Climate and Deepen Community Engagement and Public Advocacy.

SUSTAINABILITY MODULES

CEEGR 4880—Engineering Design II
EOP Material Selection 3 and Design 1

Overview: In our senior design course, students are asked to develop design alternatives and evaluate them with respect to technical, environmental, and social appropriateness using a decision matrix, as appropriate for the project. This project provides tools for evaluating the social and environmental dimensions.

Learning Objectives:

1. Identify social, economic, and environmental impacts of an engineering project alternative.
2. Describe and utilize decision making tools that rank the relative importance of project impacts in a repeatable and justifiable way.
3. Describe processes that can equitably allocate resources to mitigate negative project impacts.

ECEGR 3120: Semiconductor Devices and Circuits
EOP Materials Selection 1 and EOP Design 2

Overview: This module aims to provide students with a fundamental understanding of sustainability, environmental justice, and supply chain management in the context of semiconductor design and fabrication. Students will evaluate the implications of using rare and/or dangerous materials in electronic devices, considering the environmental, social, economic, health, and safety aspects. They will explore ways to mitigate the negative consequences through unique design approaches.

Learning Objectives:

1. Demonstrate an understanding of the interconnectedness of environmental, social, and economic systems as it relates to sustainability and environmental justice.
2. Identify potential impacts of materials through the supply chain – from raw material extraction through manufacturing, use, reuse, and end of life – with a focus on minimizing negative impacts to the planet and all people.
3. Explore design strategies that promote sustainability throughout the device lifecycle.

ECEGR 3500: Electrical Energy Systems
EOP Social Responsibility 1 and 4

Overview: This module aims to provide students with a comprehensive understanding of UN Sustainable Development Goal 7: Affordable and Clean Energy. It will cover the importance of universal access to energy, the role of renewable energy sources, and strategies for promoting sustainable energy solutions.

Learning Objectives:

1. Explain the significance of SDG 7 in the context of global sustainability.
2. Identify the key components of affordable and clean energy.
3. Analyze current challenges and opportunities related to energy access and sustainability.
4. Develop strategies for promoting renewable energy solutions in various contexts.
5. Assess local energy policies and practices in relation to SDG 7.

MEGR 4210 Thermodynamics II
EOP Systems Thinking 1 and 3

Overview: This three-week module asks students to design devices by performing technical calculations and analyzing them in broader contexts. Topics include setting broad system boundaries, empathic and ethical considerations, local political landscape, societal and cultural awareness, and environmental and economic impacts.

Learning Objectives:

1. Relate engineering design decisions to global, cultural, social, environmental, and economic impacts and consequences
2. Apply fundamental engineering calculations and methods to solve a design problem while empathically and ethically considering communities/societies, environmental justice, and cultural awareness
3. Research and assess local energy policies and practices, cultural norms, and societal values
4. Communicate the problem and solutions to affect broader society

MEGR 4880 Engineering Design II
EOP System Thinking 2 and 3, and EOP Social Responsibility 5

Overview: A case study of an engineering manager working with a nonprofit firm that aims to develop sustainable water filtration systems for third-world countries is presented to students. Based on the given scenario, students will discuss the impact of an engineering design through the lens of social equity.

Learning Objectives:

1. Apply engineering concepts to study the real-world problem and the solutions with empathic and ethical consideration for communities/societies, environmental justice, and cultural awareness.
2. Identify dynamic impacts between and among different parts of the system.
3. Weigh the near- and long-term costs and value of their work to the environment and society through the sustainable use of resources and engagement with stakeholders.

SCENG 3030: Humanitarian Engineering and CEEGR 3420—Environmental Engineering Chemistry
EOP Social Responsibility 4 and 5

Overview: SCENG 3030 is an entirely new course to be launched in WQ 2025. Introduces students to humanitarian engineering by emphasizing project facilitation, community engagement, and appropriate engineering technologies. The module funded by the EOP project focuses on having students explain why the Flint, Michigan water crisis was an environmental justice issue.

Learning Objectives (course and module):

1. Utilize human-centered design or other techniques to engage the community
2. Meet the UN Sustainable Development Goals
3. Address ethical and social justice considerations typical to projects.

STANDARDIZED COURSE MODULE

A standardized template has been developed for use in this project. A standard format will any faculty member teaching these courses to quickly build on this work. We intend to post completed modules to a university-wide shared course model repository accessible for all faculty. Here, we present our template in the context of an activity that we developed for use by our team members as they develop their EOP modules.

Module Title: Example Sustainable Course Module Development Activity
Student-focused synopsis of activity: In this activity, participants develop an activity or course module that emphasizes a particular sustainability outcome or objective. The goal is to develop a written documents that can be used, with minimal preparation, by course instructors to emphasize the outcome.
Objectives: The objectives should relate to the University's recently adopted **definition of sustainability**, which is: "***We define sustainability as meeting the needs of present and future generations through actions that support human and ecological health, social justice, and economic wellbeing.***"
Background information: Instructors often do not have time to research and organize the material from outside their expertise. This section is intended to provide a place to document that material. It can be provided in the form of written text/images and or videos. Videos should be located at a permanently accessible location. The background information should be presented in as general a way as possible without too much focus on a specific course. For this example activity, helpful background includes the sustainability outcomes in the Engineering for One Planet Framework.
Assignment prompt: This should be clear and concrete. In the context of this example, an appropriate prompt could be to ask participants to revise each section of this template document, but in the context of a specific sustainability-related outcome.
Detailed assignment guidelines: The modules should be developed in Word format and submitted to the EOP mini grant coordinators. After curation, we expect to share the modules with faculty university-wide on SUClimate.com, a shared Canvas group maintained by faculty fellows working on the Sustainability and Climate Change priority within the University's reimagine and reinvent the curriculum effort.
Evaluation criteria: Putting this material into a standardized format allows faculty with expertise outside the main subject area to quickly digest the material and incorporate it into courses. They are likely to evaluate the module based on:
- Presentation of sustainability background concepts
- Creative and realistic use of class time
- Conciseness
- The extent to which the module presents concrete activities that can be used directly in class with minimal preparation
- Breadth of relevance of the material

Examples: This document serves as an example of the work product intended to be produced as a result of the activity.
Optional Sections: These may include materials needed, classroom setup guidelines, time requirements, script, key concepts and terms, readings and resources, discussion questions, case studies and examples, supplementary materials, feedback and reflection, and quiz question banks.

REFERENCES

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3. Seattle University." Reigniting Our Strategic Directions: 2022-2027". (2022). Accessed December 12, 2024. https://www.seattleu.edu/media/seattle-university/strategic-directions/Seattle-University-Reigniting-Our-Strategic-Directions-2022-2027.pdf.
4. Seattle University. "Laudato Si' Action Platform." Institute for Catholic Thought and Culture. Accessed December 12, 2024. https://www.seattleu.edu/institute-for-catholic-thought-and-culture/laudato-si-action-platform/.

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