Credits 4 credits

Course Description
Assessing sustainability of biological and ecological systems is an integral part of ecological engineering practice. Various aspects of sustainability analysis include assessing technical feasibility, economic viability, environmental impacts, resource sustainability and social aspects of engineered systems. This course will provide an introduction to these aspects of sustainability with a focus on case studies that are relevant to biological and ecological engineers. This course will introduce tools to perform technical feasibility analysis, economic viability analysis, environmental risk assessment, resource sustainability assessment and life cycle assessment (LCA). This course will provide an introduction and overview of the LCA methodology, various tools to perform LCA and its use in assessing the environmental impacts. This course will also discuss the nexus of food-energy-water systems. Course will consist of lectures focusing on theory and case studies highlighting the use of these methods to assess sustainability.

Prerequisites ENGR 391 and BEE 322

Learning Outcomes
By the end of this course, you must be able to:
- Describe different aspects of sustainability.
- Evaluate technical feasibility of a given system.
- Assess economic viability of a given system.
- Evaluate environmental impacts of a given product/process using life cycle impact assessment methods.

ABET Learning Outcomes
This class will meet the following ABET outcomes:
a. Ability to apply mathematics, science, and engineering
h. Broad education necessary to understand the impact of engineering solutions in a global and societal context
j. Knowledge of contemporary issues
k. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
o. An awareness of the forces that impact design and decision making, such as resource limitations, system constraints, and the identified goals for improvement

Grading and Evaluation
All assignments including reports and presentations must confirm to the guidelines specified in the BEE assignment guidelines for minimum standards in graded assignments (http://bee.oregonstate.edu/current-students). Two tests (15+25% of the total grade) will be conducted. Home works will account for 40% of the grade. Final report and presentations will account for 10% and 10% of the grade respectively.
**Course Topics (Tentative)**

1. **Overview (4 lectures)**
   a. Definition of sustainability, various aspects of sustainability, emphasis on systems analysis for assessing sustainability. (1 lecture)
   b. Different sustainability indicators. (1 lecture)
   c. Overview of technologies used in the case studies during the course. (2 lectures)

2. **Technical Feasibility (4 lectures)**
   a. Methods to assess technical feasibility, estimating theoretical maximum and best case scenarios, using alternative approaches to assess technical feasibility (2 lectures)
   
   **b. Example: corn ethanol, irrigation and solar energy (2 lectures)**

3. **Economic Viability (4 lectures)**
   a. Methods to assess economic viability, review of net present value, internal rate of return, payback period. (2 lectures)
   
   **b. Example: corn ethanol, irrigation and solar energy (2 lectures)**

4. **Resource Sustainability (5 lectures)**
   a. Water: fresh water availability, types of water consumption, movement of virtual water (1 lecture)
   b. Land: land use change, arable, marginal land, CRP lands, and forests. (1 lecture)
   c. Other resources: Phosphates, non-renewable resources (1 lecture)
   d. **Example: corn ethanol, irrigation and solar energy (2 lectures)**

5. **Environmental risk assessment: (2 lectures)**

6. **MidTerm Exam (1 lecture)**

7. **Environmental Impacts (11 lectures)**
   a. Methods to assess environmental impacts, overview of the LCA with a brief example. (1 lecture)
   b. LCA methodology (1 lecture)
   c. An overview of LCA standards with a focus on ISO 140400 series. (0.5 lecture)
   d. Introduction to LCI databases such as US LCI, Digital Commons, and EcoInvent. (0.5 lecture)
   e. Introduction to OpenLCA (2 lectures)
   f. Challenges in LCA: variation among LCAs in published literature, importance of data, system boundaries, LCA applied to agricultural systems, pitfalls and limitations of LCA. (2 lectures)
   g. Practice of LCA using OpenLCA (2 lectures)
   
   **h. Example: corn ethanol, irrigation and solar energy (2 lectures)**

8. **Social aspects of Sustainability: Policy aspects, social aspects of sustainability (one Guest Lecture: Brian Tilt, Anthropology?). (2 lectures)**
9. Case Studies (4 lectures)
   a. Case Study 1: Cellulosic and algal biofuels (2 lectures)
   b. Case Study 2: Impact of climate change on food production/water resources. (2 lectures) *(Dr. Dominique?)*

10. Summary: State of the art and future outlook. (1 lecture)

11. **Presentations: Final presentations (2 lectures)**

**Assignments:**
Homework and assignments based on the comparison of conventional wastewater treatment technologies and wetlands/pond systems.