Catalog Description: BEE 469 Ecological Engineering Design I (4 hr) Engineering design processes for ecological engineering applications, including specifications, performance criteria, timelines, and project logistics, principles and practices of working in engineering teams. PREREQ: BEE 322. Unenforced Prerequisites are ENGR391 and Senior Standing or Consent of Instructor. BEE 469 and BEE 470 are taught as a unit each year.

Required Text: None

Recommended Reading and References: Materials will be made available based on the design project.

Instructional Objectives
The primary objective of the design sequence is to provide students with hands-on experience in solving the kind of complex open-ended design problems they are likely to encounter in ecological engineering, including satisfying legal, economic, social and environmental constraints. Other objectives include providing the students with experience in the real-world application of mathematics, science, engineering economics, ethics and other disciplines related to engineering analysis and design, and a clearer perspective on the value of research in addressing contemporary problems in engineering design. Attainment of oral and written communication to achieve a level commensurate with professional engineering practice will be a fundamental objective.

The primary focus of the design sequence will be an open-ended design project that promotes critical thinking. The project will have four major components:

1. Develop a feasible engineering solution to a design problem.
2. Perform quantitative evaluation of an engineering project considering ecological, social and economic impacts of the project.
3. Assess project sustainability, economic viability and compliance to applicable laws.
4. Present the results in oral and written form at a level commensurate with professional practice.

Organization of the Course
The design sequence will involve solving an open ended problem. Finding a solution to open ended problems involves a lot of peer-peer discussions and evaluation of technical results using multiple approaches considering technical, economic, legal, regulatory and social factors. A significant part of the course (about 18 lectures) will consist of in-class discussion in an informal setting. Each team will be present an overview of their findings and technical calculations to the class every week. The student teams will lead the design process, discussions in/outside the class and communication with the clients. Instructors will only
facilitate and not lead these aspects of the project. Instructors will respond to all student requests, help in locating technical resources, oversee the design process, provide timely feedback on all reports and other written/oral communications and help in any conflict resolutions. A background of some important technical aspects, engineering design process, example case studies will be presented through a series of lectures. Additional lectures professional development emphasizing the written and oral communication will also be presented.

**Evaluation of Student Performance**

Ecological design always involves a team effort. As a result, student participation as part of the design team, as evidenced through meetings, presentations, written reports and a project log, will be a major determinant in the final grade achieved. Gaining an “A” in the class requires demonstration of consistently effective team performance. Apart from some basic lectures at the outset of the sequence, students will be in charge of their projects, with the faculty serving as advisors, who will respond to requests for assistances. Communication skills, as well as technical soundness, will be evaluated. Every two weeks students will present progress oral reports and written memos outlining ongoing progress, technical problems encountered and strategies for problem resolution, and will also summarize their work in a longer presentation at the end of each term. A project log will be an integral part of this process. Interim design report consisting of detailed discussion of current state of the art, detailed discussion of technical alternatives, rational for choosing the proposed solution. A final design report will be required at the end of the second term. Final design report will consist of all the elements of revised Interim report in addition to the final design calculations and recommendations. A cover letter to the potential customer and executive summary are integral elements of both reports. Revising reports in response to peer and instructor evaluations/comments are part of the course learning objectives. The approximate grading breakdown for BEE 469/470 will be as follows:

**Table 1. Grading breakdown for BEE 469.**

<table>
<thead>
<tr>
<th>BEE 469</th>
<th>BEE 470</th>
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</thead>
<tbody>
<tr>
<td>• Project log – 10% (approximately 3000 words)</td>
<td>• Project log – 10% (~ 3000 words)</td>
</tr>
<tr>
<td>• Memos-20% (~1000 words for memos)</td>
<td>• Memos – 20% (~ 2000 words)</td>
</tr>
<tr>
<td>• Site visit Reports- 5%</td>
<td>• Oral Presentations – 20%</td>
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<tr>
<td>• Individual technical report – 15% (~ 2000 words)</td>
<td>• Final design report – 40% (~7000 words, based on the Interim project report )</td>
</tr>
<tr>
<td>• Oral Presentations – 20%</td>
<td>• Professionalism/team participation - 5%</td>
</tr>
<tr>
<td>• Interim design report – 20% (~5000 words)</td>
<td>• Peer review of technical calculations: 5%</td>
</tr>
<tr>
<td>• Professionalism/team participation -5%</td>
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</table>

*BEE 469 Learning Outcomes:*

The primary objective of the design sequence is to provide students with hands-on experience in solving large-scale open-ended design problems in bioprocess engineering, while satisfying legal, economic, social and environmental constraints. Other objectives include providing the students with experience in the real-world application of mathematics, science, engineering economics, ethics and other disciplines related to engineering analysis and design,
and a clearer perspective on the value of research in dealing with problems in engineering design.

Students should be able to accomplish the following upon completion of the course:

1. Develop the design of an engineering project considering ecological, social and economic impacts of the project.
2. Understand the design concerns with respect to project sustainability, long term economic viability and compliance to local, state and federal laws.

**BEE 469 WIC Learning Objectives:**

BEE 469 is also a Writing Intensive Course (WIC) and together with BEE 470 can be used to satisfy the WIC requirements for the BEE undergraduate program. At least 25% of the course will involve individual writing (memos and individual technical report) while the project log, site visit reports, Interim design report and the oral presentations will be group effort. Therefore in addition to the regular course outcomes, the students should be able to accomplish the following upon completion of the course:

1. Develop and articulate content knowledge and critical thinking in the discipline through frequent practice of informal and formal writing.
2. Demonstrate knowledge/understanding of audience expectations, genres, and conventions appropriate to communicating in the discipline.
3. Demonstrate the ability to compose a document of at least 2000 words through multiple aspects of writing, including brainstorming, drafting, using sources appropriately, and revising comprehensively after receiving feedback on a draft.

**ABET Bioengineering Program Learning Outcomes met by BEE 469:**

- c. Ability to design a system, component, or process to meet desired needs;
- h. Broad education necessary to understand impact of engineering solutions in global, economic, environmental and societal context;
- l. An ability to apply knowledge in a specialized area related to ecological engineering;
- n. Ability to model and design ecological systems;
- o. An awareness of the forces that impact design and decision making, such as resource limitations, system constraints, and the identified goals for improvement;

**Statement Regarding Students with Disabilities**

"Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098."

**Link to Statement of Expectations for Student Conduct:**

*ANY act of dishonesty will result in consequences up to and including immediate failure of this course.* Three examples of dishonesty include copying during an exam, writing a paper for another student, or copying someone else’s homework. For additional information see the Office of Student Conduct and Community web-site at [http://oregonstate.edu/admin/stucon/index.htm](http://oregonstate.edu/admin/stucon/index.htm).
Existing irrigation practices around the city of Ontario, Malheur County, Oregon while in compliance with all current regulations may have a potential issue with future water quality and testing rules as a part of FDA’s Food Safety Modernization Act. The proposed FDA regulations could impact practices of onion growers.

The new rules would limit the $E.\text{coli}$ to 126 CFU ($E.\text{coli}$ is used as an indicator species for foodborne pathogens) which are similar to the regulations for use in recreational waters. Some of the preliminary testing indicated that the loads could vary from 1 -1000 CFU. Most of the samples have a range of 100-500CFUs. Last three years of testing has indicated no $E.\text{coli} \text{157}$ and $\text{Salmonella sp.}$ presence.

Farmers in Columbia basin, Colorado and central valley of California would be impacted in a similar way with the proposed regulations as they also use surface waters for irrigation in similar conditions. Given this wide range of variations in the bacterial loads from the fields, the proposed FDA regulations and its importance to agriculture in many states, the solutions to this problem can be classified into two broad categories as indicated below. **The project options will focus on decentralized treatments options exclusively.**

### Technical Alternatives

**Decentralized Treatment Options**
- Water to be treated at individual farms to meet regulations.
  - Change distribution systems.
  - Change current irrigation system to pressurized irrigation systems and treat the water to meet the regulations using:
    - Conventional filtration systems
    - Micro- and Ultra- filtration systems
    - Ozone treatment
    - UV treatment
    - Chlorine treatment

**Centralized Treatment Options**
- Water to be treated centrally to meet regulations and supplied to individual farmers through:
  - Multiple Canal
  - Pressurized systems
  - Piped flow

Some of the challenges are:
1. Wide spatio-temporal variation in bacterial loads.
2. Complexity of the current irrigation system.
3. Sunk costs into existing farming practices.
4. Many regulatory issues involving multiple Gov't. agencies.
5. Multiple stake holders.

The overall goal of this project is to design, develop and evaluate different options to meet the proposed regulations while minimizing the economic costs and environmental impacts of the proposed design. The proposed design must strive to minimize the impact on existing agricultural practices.

At a minimum your design must include the following elements:
1. Meet the regulatory aspects.
2. Meet functionality constraints in terms of water usage patterns and existing agricultural practices.
3. Measures to conserve water, harvest water, improve water reuse/recycle and reduce discharge.
4. Measures to conserve energy and improve energy efficiency.
5. Consider climatic factors in your design.
6. Economic considerations in all designs (Capital versus operating costs, comparison to current state of affairs).
7. Regulatory aspects (ex. is the implementation of the project plan permitted by law?)
8. Scalability to accommodate different funding scenarios.
Provide your design, evaluate the net present value of the design and life-cycle analysis.

**Text:** Class notes and handouts. No required text.

**References and Resources:**
1. Aerial images of the site.
2. On-site surveys.
3. Information from professionals involved in the project. (Prof. Chad Higgins, Hong Liu and Dr. Clinton Shock will serve as the project technical advisors).

**Lectures**
A total of 16 lectures will be delivered to cover various aspects of the project design and development.

- **Technical Lectures:**
  1. Engineering design process, Gantt charts (two lectures). Week 1
  2. Guest lectures by technical experts (three lectures). Week 1 and 2
  3. Case study of an engineering design problem (two lectures). Week 2
  4. Case study of an engineering design problem (two lectures). Week 2
  5. How to develop a research/project proposals (two lectures). Week 3

- **Professional Development:**
  1. Written Communication: Memo, report and citation formats (one lecture). Week 2
  2. Writing an Effective Resume and/or Cover letter (one lecture): Week 3
  3. Oral Communication: Oral, written, memo, report and citation formats (one lecture). Week 4
  4. Interviewing Skills (one lecture): Week 5
  5. Job and/or internship search strategies (one lecture): Week 6

**Site visit**
Site visit to John Day River Project Site, Ontario OR, and Hermiston OR will be conducted from 11.00AM, 11th October to 13 October.

**Data Management**
All students/teams are required to maintain up to date documentation of their individual/team project memos, meeting minutes, presentations to their respective group folders.

- 1. Project memos (one page), oral presentation slides and interim technical report will be considered public documents and posted on the course website.
- 2. A hard copy (three-ring binder) and soft copy (flash drive) of all documentation in a three ring binder submitted at the end of the course (10th week)
Tentative schedule for the design sequence BEE 469/470

BEE 469 (Fall, 2013)
1. Design problem and formation of teams: 1st week
2. Review of progress in one page project memos: 2, 4, 6, 8 and 10th week.
3. Meeting minutes: Every meeting of the group.
4. Preliminary studies on technical alternatives: 4th week
5. Project schedule (Gantt charts): 2nd Week.
6. Lectures: Sixteen lectures covering strategies for engineering design, example case studies, project site visit, strategies for effective professional communication, and how to bid an engineering project (see details above)
7. Site visit reports (two pages): one week from the date of site visit.
9. Team presentation (oral) of design: 8th week.
10. Interim Technical Report (ITR): This comprehensive group report must include: review of literature, technical alternatives discussed in the group, final design layout and technical/economic/regulatory considerations used for preparation of the final design layout. Finals week (~5000 words).

BEE 470 (Winter, 2014)
12. Review of the ITR: Instructor feedback must be considered and any issues pointed out in the ITR must be fully addressed. 1st week.
13. Review of progress and project memos: 2, 4, 6, 8 and 10th week.
14. Meeting Minutes: Every meeting of the group.
15. Perform engineering design calculations with budgets: 1-3 week.
16. Team presentation (oral) of design calculations: 4th week.
17. Critique of team designs and Instructor review of design calculations: 4th week.
18. Respond to critique and feedback: 5-6th week.
19. Preparation of Final Report (FR): This report must include the detailed design calculations, reviewed ITR, covering letter. 6-9th week.
20. Team presentation of final design: 9-10th week.
21. Final Report submission: Finals week (~7000 words); 10th week.
22. Evaluation by external panel, instructor and peer review of the FR: 10th week.
Report Guidelines

General Guidelines for All Communications

1. All communications must be in grammatically correct English.
2. Use SI units in all your calculations. You may report your final numbers in non-SI units.
3. Pay attention to the significant digits in all your calculations.
4. All communications must be in clear and concise form.
5. All assignments must follow BEE departmental guidelines for all assignments. The guidelines in this document are in addition to these guidelines.

Project Log Guidelines

The purpose of the project log is to document the project and provide a complete detailed overview to your team, clients and other engineers who may refer to your work at a later date. A hard copy (three-ring binder) and soft copy (flash drive) of all documentation in a three-ring binder submitted at the end of the course. All students/teams are required to maintain up to date documentation of their individual/team project memos, meeting minutes, presentations to their respective group folders. Project memos, oral presentation slides and interim technical report will be considered public documents and posted on the course website. All project reports must consist of following sections.

1. Project outline and objectives.
2. Gantt charts.
3. Team member and their responsibilities.
4. Project meeting minutes.
5. Project memos to the clients.
6. Individual, interim and final technical reports.
7. Slides of all oral presentations.
8. Details of all technical calculations including assumptions and data sources.
9. List of references. Consistently follow the format of any scientific journal format to cite the references.
10. Appendices: Appendices can consist of important resources such as copies of important papers, reports, product brochures and communications with experts etc.

Project Technical Alternatives Report

The primary objective of a project Technical alternatives report is to briefly describe various solutions that can solve the engineering design problem. The report is typically a brief document that can have figures to convey key ideas. It must also include a bulleted list of advantages/benefits, disadvantages/concerns and ideas that need to be further explored.

Project Memo Format

The primary objective of a project memo is to communicate the status of the project any important developments and any unexpected situations/issues to the client in a timely manner. While the styles of memos vary, all your memos must contain the following elements:
1. A one page (or less) cover letter addressing the client summarizing the big picture for the project.
2. A brief one/two page memo containing three sections: project accomplishments, plans for next two weeks and data needs from the client as a brief bulleted list.
3. Any important data, calculations, documents or references can be attached as appendices.

**Site Visit Reports**

The purpose of a site visit report is to accurately document your observations during the visit to a project site. Site visits are a team effort and must represent the summary of observations made by all team members. Site reports must be limited to 500 words not including the appendices.

**Individual Report (IR) Guidelines**

The primary objective of the IR is to document and assess the individual team member contribution to the research into different aspects of the design alternatives. As well, the report provides the student an opportunity to practice writing, and demonstrate their ability to communicate formally in well-crafted written English. The report must be comprehensive in scope and synthesize the individual research topic components into a logical narrative. It must not consist of poorly connected paragraphs. The overarching structure and flow of the document will be a central aspect of the evaluation of merit. You are encouraged to adopt a similar report format as other team members.

**Specific Guidelines**

1. The IR will be approximately 2000 words, and may include any number of figures or appendices.
2. The IR must include following mandatory sections:
   a. Comprehensive survey of technology field and alternative technologies.
   b. Technical considerations.
   c. Economic considerations.
   d. Environmental and social impact considerations.
3. The report (15% of the grade) will be evaluated on
   a. content (60%: 45% for technical content; 5% for addressing economic concerns; 5% for environmental and sustainability aspects; 5% for social impacts).
   b. clarity (15%): The ability to communicate clearly with the audience without too much technical jargon.
   c. coherence (15%) and : An organized development of the key concepts, data and references to present the unified solution to the design problem.
   d. language (10%): Ability to write in grammatically correct and simple language.
4. The report must be submitted by the end of 6th week of the class. [8th Nov 2013]

**Interim Technical Report (ITR) Guidelines**

The primary objective of the ITR is to document the final design and the alternative designs considered. This comprehensive group report must include: review of literature, technical alternatives discussed in the group, final design layout and technical/economic/regulatory considerations used for preparation of the final design layout. Although detailed calculations regarding the technical design are not required at this stage, it is expected that simple economic or design calculations will be performed to select one option from the list of alternatives considered. The report should specifically address appropriate engineering standards applied in
The primary objective of the technical report is to document the final design and the alternative designs considered. Detailed calculations used in the technical design must be reported. The report should specifically address appropriate engineering standards applied in your design and analysis, and should identify and discuss multiple realistic constraints observed and addressed in the design process. The report must be comprehensive in scope and demonstrate integration of technical knowledge, knowledge about the local, state and federal laws, socio-economic factors used to arrive at the design solution.

The FR will be returned to the team with instructor and external panel feedback and it is expected that the comments will be fully addressed and corrected FR returned to instructors within a week.

Specific Guidelines

1. The final design report will be approximately 7000 words, and may include any number of figures or appendices.
2. The FR must include following mandatory sections:
   a. Comprehensive survey of technology field and alternative technologies.
   b. Technical constraints that guided the choice of a particular design alternative.
   c. Economic considerations.
   d. Environmental and social impact considerations.
   e. Compliance with relevant federal, state and local laws.

3. Elements of IR can be used in ITR, however at least 30% of the ITR (>1500 words) must consist of material specific to ITR.

4. The report (20% of the final grade) will be evaluated on
   a. content (60%: 30% for technical content; 10% for addressing economic concerns; 10% for environmental and sustainability aspects; 5% for social impacts; 5% for compliance with relevant federal, state and local regulations),
   b. clarity (15%): The ability to communicate clearly with the audience without too much technical jargon.
   c. coherence (15%) and : An organized development of the key concepts, data and references to present the unified solution to the design problem.
   d. language (10%): Ability to write in grammatically correct and simple language.

5. The report must be submitted by the end of 10th week of class. [6th Dec 2013]
a. Comprehensive survey of technology field and alternative technologies.
b. Technical constraints that guided the choice of a particular design alternative.
c. Economic considerations.
d. Environmental and social impact considerations.
e. Compliance with relevant federal, state and local laws.
f. Engineering calculations, sustainability assessments for the design case. Include a
discussion of methods, standards used for design and sample calculations
detailed calculations can be presented in appendix).

3. Elements of ITR can be used in FR, however at least 30% of the FR (>1500 words) must
consist of material specific to FR.

4. The report (40% of the final grade) will be evaluated on
   a. content (60%: 30% for technical content; 10% for addressing economic concerns;
      10% for environmental and sustainability aspects; 5% for social impacts; 5% for
      compliance with relevant federal, state and local regulations),
   b. clarity (15%): The ability to communicate clearly with the audience without too
      much technical jargon.
   c. coherence (15%) and : An organized development of the key concepts, data and
      references to present the unified solution to the design problem.
   d. language (10%): Ability to write in grammatically correct and simple language.

5. Final reports are due by 10th Week of class.