

ECOLOGICAL ENGINEERING SCIENCE CEES 5363

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Office hours: Tuesdays and Thursdays 1330-1445 or by appointment

Prerequisites: Senior or graduate standing and background in biology, ecology or engineering
Location: CEC 031
Times: Tuesday and Thursday 1200-1315
Credit hours: 3 credit hours

Course description

Ecological engineering is defined as *the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both*. It is distinct from both environmental engineering and ecology and uses a systems perspective based on the premise that sustainable solutions require working *with* natural ecological and biogeochemical processes and not against them. Ecologically engineered systems are designed to require less fossil fuel input, produce less pollution and represent cost-effective alternatives to traditional energy- and resource-intensive technologies. This graduate class will provide an in-depth examination of this discipline through critical analyses of current literature, team projects, field trips and discussions.

Course objectives

- To critically examine and understand the key concepts, terms, relationships, utility, and acceptability of ecological engineering as a discipline
- To apply the knowledge and understanding gained to design solutions for real-world environmental problems as part of an interdisciplinary team
- To learn how ecological engineering may be integrated into traditional engineering approaches by valuing the way nature solves problems
- To understand that energy is the currency of life and that energy flow is the key process in all fields
- To determine the proper placement of ecological engineering in the academic arena and to identify further sources of learning on ecological engineering

Required Readings

- Mitsch, W.J. and S.E. Jørgensen. 2004. *Ecological Engineering and Ecosystem Restoration*. John Wiley and Sons, Inc., 411 pp.
- Several additional required readings available on the course Canvas site

Supplemental Texts (to complement required readings)

- Matlock, M.D. and R.A. Morgan. 2011. *Ecological Engineering Design: Restoring and Conserving Ecosystem Services*. John Wiley and Sons, Inc. 352 pp.
- Jørgensen, S.E. 2009. *Applications in Ecological Engineering*. Academic Press, 392 pp.

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- Kadlec, R.H. and S.D. Wallace. 2009. *Treatment Wetlands*, 2nd ed. CRC Press LLC. 1016 pp.
- Kangas, P.C. 2004. *Ecological Engineering: Principles and Practice*. Lewis Publishers. 452 pp.
- Odum, H.T. 1996. *Environmental Accounting: EMERGY and Environmental Decision Making*. John Wiley and Sons, Inc., 370 pp.
- Mitsch, W.J. and S.E. Jorgensen (eds.) 1989. *Ecological Engineering: An Introduction to Ecotechnology*. John Wiley and Sons, Inc., 472 pp.
- Odum, H.T., 1981. *Energy Basis for Man and Nature*, 2nd ed, McGraw-Hill, 337 pp.

Course Management

We will be attempting to use Canvas course management software in this course, <http://canvas.ou.edu/>. Much class information will be disseminated via Canvas and email. Students are encouraged to submit questions to the instructor via email at any time. Responses will be made as quickly as possible. It is the responsibility of each student to regularly access their OU email account.

Class Policies

Codes of behavior: Each student should acquaint her or his self with the University's codes, policies, and procedures involving academic misconduct, grievances, sexual and ethnic harassment, and discrimination based on physical handicap. Any instance of classroom disruption will be dealt with in a prompt and serious manner.

Cell phones and other electronic devices: Although note-taking on laptops or other devices is permitted, use of any electronic device for anything other than course-related work is prohibited. ***Turn off cell phone ringers/beepers during class time and completely refrain from text messaging.*** All electronic devices must be stored out of view to both the students and instructor during class lectures and discussions. If you must leave your cell phone engaged for some reason, please discuss this with the instructor.

Reasonable accommodation: Any student in this course who has a disability that may prevent the full demonstration of his or her abilities should contact Dr. Nairn personally as soon as possible so an appropriate contact may be provided to discuss accommodations necessary to ensure full participation and facilitate your educational opportunities. For more information, please visit <http://www.ou.edu/drc.html>. The OU policy states:

"The University of Oklahoma is committed to the goal of achieving equal educational opportunity and full participation for students with disabilities. Consistent with the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990, as amended, The University of Oklahoma ensures that no "qualified individual with a disability" will be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination solely on the basis of disability under any program or activity offered by The University of Oklahoma. Accommodations on the basis of disability are available by contacting the Disability Resource Center in Room 166, Goddard Center (405) 325-4173/TDD or (405) 325-3852 Voice."

Adjustments for pregnancy/childbirth related issues: Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact Dr. Nairn as soon as possible to discuss. Generally, modifications will be made where medically necessary and similar in scope to accommodations based on temporary disability. For commonly asked questions, please see <http://www.ou.edu/eoo/faqs/pregnancy-faqs.html>.

Title IX resources: For any concerns regarding gender-based discrimination, sexual harassment, sexual misconduct, stalking, or intimate partner violence, the University offers a variety of resources, including advocates on-call 24/7, counseling services, mutual no contact orders, scheduling adjustments and disciplinary sanctions against the perpetrator. Please contact the Sexual Misconduct Office 405-325-2215 (8-5, M-F) or OU Advocates 405-615-0013 (24/7) to learn more or to report an incident.

Religious observances: It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty.

Academic misconduct: It is the responsibility of each student to be familiar with the definitions, policies and procedures concerning academic misconduct. **Instances of academic misconduct and classroom disruption will be dealt with in a serious and appropriate manner.** The Academic Misconduct Code is available at <http://integrity.ou.edu/>

By accepting this syllabus, all students agree to the following contract: "As a member of The University of Oklahoma, I understand that enrollment creates special obligations beyond those attendant upon membership in the general society. In addition to the requirement of compliance with the general law, I assume the obligation to comply with all University policies and campus regulations. I understand that behavior that it considered, by the instructor; to be a disruption or obstruction of teaching will not be tolerated. I further understand that if my behavior is considered to be of such a nature, I will be asked to leave the classroom and may be formally charged under The University of Oklahoma Student Code of Responsibilities and Conduct and, if so, will be subject to appropriate sanctions under Title 17 of the Code. I also agree to uphold the academic integrity of The University of Oklahoma. I understand that any incidents of academic misconduct discovered by the instructor will be handled in accordance with the Academic Misconduct Code."

For every assignment, students are encouraged to adhere to the *Integrity Pledge* as provided by the Student Government Association and Faculty Senate: "On my honor, I affirm that I will neither give nor receive inappropriate aid in the completion of this exercise."

A special note on plagiarism: Submission of written documents is a substantial component of student evaluation in this course. All students are encouraged to familiarize themselves with information on plagiarism available at <http://integrity.ou.edu/>. Be sure to examine this information, including the videos, tutorial and document entitled "Nine Things You Should Already Know about Plagiarism" (http://integrity.ou.edu/files/nine_things_you_should_know.pdf).

The University subscribes to the online plagiarism-detection service Turnitin.com. Turnitin is integrated into the course management system. Papers submitted automatically generate an originality report indicating passages identical to other student papers or Internet sources. Further information is available from the integrity website.

Teams: Based on student status and the information provided on an initial student questionnaire, the instructor will assign individual students to multidisciplinary teams. Students are expected to work with their teams throughout the semester, especially on Readiness Assessment Tests, class presentations,

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and written reports. **Peer evaluations** will be conducted periodically throughout the semester (typically when a deliverable is due) to ensure that all individual team members are participating equitably in team assignments. If problems are identified, immediate action will be taken to address the known issues.

Assignments and grading: Assignments, examinations, or projects worth less than 10 percent of a student's grade may be assigned at any time prior to pre-finals week and may be due during pre-finals week. However, no assignments, examinations, or projects may be due on the last two days of pre-finals week. Assignments, take-home examinations, in-class examinations, or projects worth more than 10 percent of a student's grade have been scheduled at least 30 days prior to the first day of finals and must be due or given prior to pre-finals week. Any assignment that is to take the entire semester to complete (the team semester project in this course) may be accepted or presented during pre-finals week and this syllabus explicitly states that the assignment can be turned in prior to pre-finals week. Special requests made by students for an extension of assignment deadlines into pre-finals week may be granted subject to the discretion of the instructor.

Making up work: Only Provost-approved university-sponsored activities such as scholarly competitions, fine arts performances, academic field trips, and legally required activities, such as emergency military service and jury duty, are covered by these guidelines. If notice is given two class periods before an exam or quiz (excluding pop quizzes), the instructor will make every effort to find a reasonable accommodation. Students missing an exam because of jury duty must be allowed an accommodation by OU policy. Students missing class due to illness must be supported by a certified note of illness. Student's missing any assignment or exam for other reasons not specified herein will be subjected to a failing grade for said assignment.

Student responsibilities and expectations

Attendance/Participation: Attendance at all class sessions and participation in discussions is expected of all students, except when **prior** arrangements have been made with the instructor. Absences for illness or family emergencies will be accommodated if attempts to contact the instructor occur **before class begins**. Lecture sessions will begin promptly - **be on time!** It is part of your grade.

In addition, in-class discussions will play a critical role in our evaluation of ecological engineering science. It is expected that **all students ask and answer questions**, participate in class conversations and debate topics of interest. Those students who do not volunteer in these conversations will be called upon to answer instructor-initiated questions. Remember, it is part of your grade.

Readiness Assessment Tests (RATs): RATs are unannounced and will be in the multiple-choice format and based solely on assigned readings. Students will first take an individual RAT, then the same RAT will be completed as a team. Individual students will have the opportunity to appeal team results if necessary. After the RAT, opportunities to apply the knowledge gained will be provided. student scores for RATS will be based equally upon both individual and team results.

Scholarly Reviews: A great deal of this course revolves around analysis of the current literature. **Students will choose two appropriate, instructor-approved, peer-reviewed, technical journal articles from the field of ecological engineering science about which to write scholarly reviews.** Articles from the popular press (e.g., *New York Times*, *Newsweek*, etc.), trade journals (e.g., *Land and Water*, *New*

Scientist, etc.), environmental magazines (e.g., *National Geographic*, *Audubon*, etc.) or World Wide Web pages (any and all web pages) will not be accepted.

Only refereed journal articles examining original research are appropriate; review papers are not. The journal *Ecological Engineering* is a principle source, and several other journals cover related topics, e.g., *Ecological Applications*, *Restoration Ecology*, *Mine Water and the Environment*, *Wetlands*, *Journal of Environmental Quality*, *Water Research*, etc. Original research germane to the subject may be found in many journals. Please see the list posted on the Canvas site.

Each student will submit a written critical review of each approved article. Scholarly reviews should consist of 1) a brief summary demonstrating that the student understood the technical content of the article and 2) a critical and insightful review of the article. The essence of the scholarly review is that the student demonstrates a critical analysis *beyond* the author's discussion and conclusions. Scholarly reviews should be a least three *full* pages in length (inclusive of any tables or figures which should not be excessive), 12-point Times New Roman font with 1.5-line spacing. They should include at least five appropriate literature citations that place the approved article in context and help buttress students' arguments. More details may be found on the Canvas site.

Both scholarly reviews are being assigned on the first day of class and selected articles (topics) for the first scholarly review are due for approval in two weeks. The full original article must be submitted to the instructor electronically through Canvas. Because each student must provide a unique article for instructor approval, students are encouraged to start literature searches now so adequate time is available for writing of the scholarly review. We will follow the "first come, first serve" policy - if a student chooses an article than has already been approved for someone else, then they must find a different article.

Team Semester Project: A significant portion of this course is devoted to a team semester project examining a real-world application of ecological engineering science. In Spring 2017, student teams will develop designs for **restoration of a reach of Bishop Creek**, in Eastwood Park in Norman, OK. Opportunities for site visits, perhaps outside of scheduled class times, will be provided. Like many urban streams, development (e.g., increased watershed impervious coverage, channelization, stormwater pollution, etc.) has detrimentally impacted Bishop Creek. The stream has been degraded physically, chemically and biologically. Working with several local non-profit, educational and government partners, the goal of the team semester project is the creation of a stream restoration design utilizing ecological engineering principles. Teams will research the history of the site and the problems, gather available data, and examine the potential for ecological engineering applications. Additional details are provided in the Bishop Creek Restoration Team Semester Project Assignment found on Canvas.

Teams will submit **interim and final written and oral reports** on the project, including all available data (both secondary or original), and providing details of their sustainable ecological engineering design. Each final project written report should be a least 15 *full* pages in length (including any tables or figures), 12-point Times New Roman font with 1.5-line spacing and include appropriate literature citations (at least 30) and an appropriate energy systems diagram describing the proposed restoration design. Interim written reports (essentially a 50% design report) are due 09MAR and final written reports are due 27APR.

All student teams will also provide 10-minute project interim oral presentations using PowerPoint software to the class on 09MAR. Twenty to thirty minute final oral presentations will be provided on 27APR; exact dates and times are yet to be determined. All team members must participate equitably in the preparation of the oral presentations, although not all team members must speak.

Each student is expected to participate equitably in the full development of all team semester project deliverables. Remember - peer evaluation scores will be included in development of grades.

Final Exam: A comprehensive final exam will test the understanding of fundamental ecological engineering science concepts and current applications as they relate to problems covered in the course.

Course grading:

Evaluation	Important Dates	%
Participation/Attendance		15
Readiness Assessment Tests	As needed	15
Scholarly Review #1	Assigned: 17JAN; Topic: 31JAN; Due: 14FEB	15
Scholarly Review #2	Assigned: 17JAN; Topic: 28FEB; Due: 21MAR	15
Team Semester Project Interim Deliverable	Assigned: 24JAN; Due: 09MAR	10
Team Semester Project Final Deliverable	Assigned: 24JAN; Due: 27APR	20
Comprehensive Final Exam	1330-1530 on 08MAY	<u>10</u>
		100

Topical Course Outline

Date	Topic	Assigned Reading#	
T 17-Jan	Introduction and Definitions	pp. 1-39	SR #1 and #2 assigned
R 19-Jan	Philosophy and Ethics of Ecological Engineering	Odum and Odum 2006; Kangas, 2004	
T 24-Jan	Classification and Uses/Semester Project Overview	pp. 40-55	Semester Project assigned
R 26-Jan	Ecosystems: Ecology, Biogeochemistry and Energy	pp. 56-93	
T 31-Jan	Ecological Design Principles and Methods	pp. 94-102	SR#1 topic due
R 02-Feb	Emergy Analyses and Systems Modeling	pp. 339-366; Odum 1996	
T 07-Feb	Ecological Economics	Kangas 2004	
R 09-Feb	Stream and Riparian Rehabilitation	pp. 125-162	
T 14-Feb	Lake and Reservoir Restoration	pp. 105-124	SR #1 written deliverable due
R 16-Feb	Wetland Creation and Restoration	pp. 163-194	

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T	21-Feb	Stormwater Treatment	Bedan and Clausen 2009	
R	23-Feb	Agricultural Runoff Treatment	Dunne et al 2012	
T	28-Feb	Municipal/Agricultural Wastewater Treatment	pp. 230-262	SR#2 topic due
R	02-Mar	Soil Bioremediation/Phytoremediation	pp. 263-286/ Vangrosveld et al 2009	
T	07-Mar	Prairie Restoration	Winter et al 2012	
R	09-Mar	Semester Project Interim Deliverable Oral Presentation/Written Document	---	Semester Project Interim Deliverable
T	14-Mar	<i>Ecological Engineering on South Padre Island</i>	<i>Spring Break</i>	
R	16-Mar	<i>Ecological Engineering on South Padre Island</i>	<i>Spring Break</i>	
T	21-Mar	Passive Treatment of Mine Drainage	Watzlaf et al 2004 pp.1-53; Nairn et al 2010; Strosnider et al 2011	SR #2 written deliverable due
R	23-Mar	Passive Treatment of Mine Drainage	Watzlaf et al 2004 pp.54-72; Amezaga et al 2011	
T	28-Mar	Disturbed Land Reclamation	pp. 287-308	
R	30-Mar	Agro-Ecological Engineering/International Applications	pp. 309-335	
T	04-Apr	Solid Waste Management	Kangas 2004	
R	06-Apr	Semester Project Team Work	---	
T	11-Apr	Semester Project Team Work	---	
R	13-Apr	Semester Project Team Work	---	
T	18-Apr	Coastal Ecosystem Restoration	pp. 195-229	
R	20-Apr	Life Cycle Assessment/ Industrial ecology	Kloepffer 2009; Tilley 2008	
T	25-Apr	Microcosmology/Living Machines	Walford 2002	
R	27-Apr	Semester Project Final Deliverable Oral Presentation/Written Document	---	Semester Project Final Deliverable
T	02-May	Ecological Engineering Education	Diemont et al 2012; Jones 2012	
R	04-May	Future of Ecological Engineering	---	

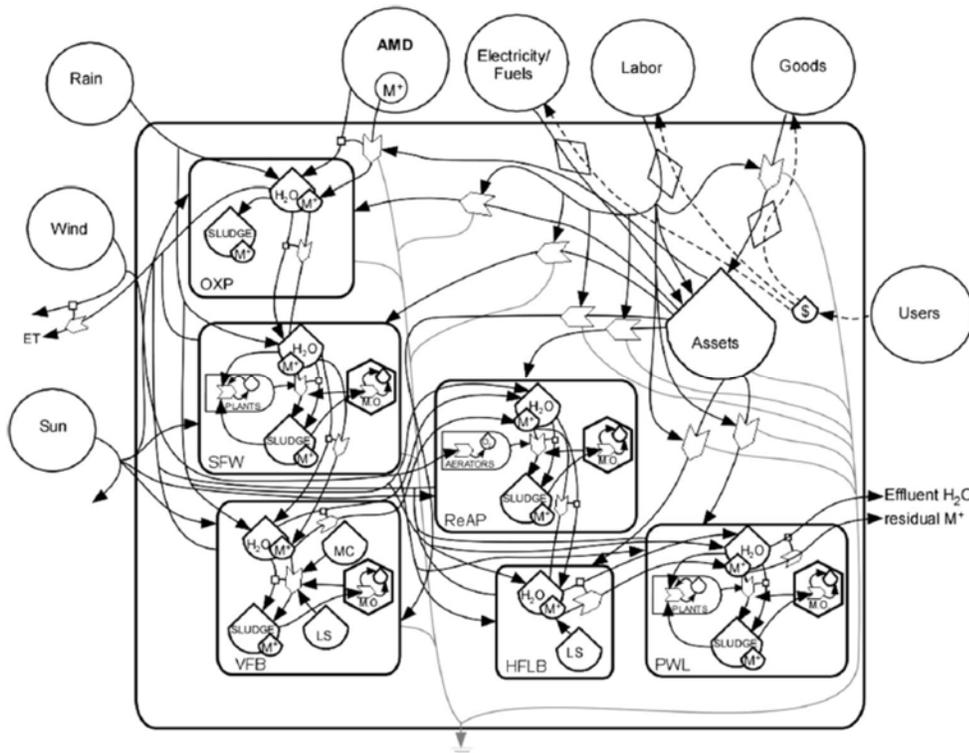
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M 08-May Final Exam, 1330-1530

#All readings in Mitsch and Jorgenson (2004) unless otherwise noted.



Aerial photograph of the Mayer Ranch mine drainage passive treatment system at the Tar Creek Superfund Site, Ottawa County, OK. This full-scale ecological engineering field research site has been in operation for over eight years, successfully treating water contaminated with elevated iron, zinc, lead, cadmium and arsenic concentrations. Process units include an oxidation pond, parallel trains of surface flow wetlands, vertical flow bioreactors, re-aeration ponds, horizontal flow limestone beds and a final polishing wetland/pond.



Energy systems diagram of construction of the Mayer Ranch mine drainage passive treatment system (from Winfrey, B.K., R.W. Nairn, D.R. Tilley and W.H. Strosnider. 2015 Energy and Carbon Footprint Analysis of the Construction of Passive and Active Treatment Systems for Net Alkaline Mine Drainage. *Mine Water and the Environment* 34:31-41. (DOI 10.1007/s10230-014-0304-6).