CEE 6984 - Nanotechnology for Environmental Sustainability

Tuesday-Thursday 11:00-12:15, McBryde 201

Instructor: Peter Vikesland, pvikes@vt.edu

Course Synopsis

Environmental sustainability is an important 21st century goal that must be met if human society is to survive. One mechanism by which such success can be achieved is through the development of novel approaches to address critical human and ecological needs. One potential approach is to take advantage of the incredible technological gains that have been made both in nanotechnology as well as in data analytics and biotechnology. Students in this course will learn the basics of sustainability science and will then learn how nanotechnology is being used to address emerging problems such as water scarcity, antibiotic resistance, energy production, and climate change.

Course Objectives

Upon completion of the course, students will be able to:

- Describe the basic concepts of sustainability science and have the ability to convey those concepts to the general public.
- Understand the near term and future applications of nanomaterials and nanoscience, as well as the benefits and pitfalls of widespread use of these materials in society.
- Understand how nanotechnology, biotechnology, and data analytics can collectively be harnessed to address water scarcity, antibiotic resistance, energy production, climate change, and a number of other emerging threats.

Course Format

This class will be taught primarily via in-class discussions of materials from readings, videos, and lectures. *Participation in these discussions is a requirement for successful completion of the course*. Due to the collaborative nature of the course, reading assignments should be completed in advance of the class period during which they will be discussed. Some materials will be presented via Powerpoint or chalkboard lectures; however, these lectures are intended to foment in-class discussions. This is your course – you will collectively dictate how it proceeds during the semester.

Primary Text

Pursuing Sustainability: A Guide to the Science and Practice Matson, Clark, and Andersson, Princeton University Press 2016. ISBN: 978-0-691-15761-0. Additional readings will be assigned throughout the semester and will be posted on Scholar in advance of the class they will be discussed.

Grading

Class participation (40%), homework (5%), presentations (25%) and a research proposal/project (30%). Policy on class participation: Participation in this course is central to the objectives of the course. **A student's participation grade will be lowered by a full letter grade for every unexcused absence in excess of two.** A student's participation grade is based upon attendance, contributions to the course discussion, and periodic presentations summarizing assigned readings to the rest of the course participants.

Regular reading assignments and periodic homework assignments will be given. One proposal will be submitted by each student. Details of this assignment will be provided in class.

Office Hours
By appointment. [Although I will be around most afternoons in my office in 415 Durham Hall.]

Honor System
All aspects of the coursework for this class are covered by the Virginia Tech Honor System. Students are encouraged to review the Honor Code.

Special Needs
If you need adaptations or accommodations because of a disability (e.g. learning, attention deficit disorder, psychological, physical, etc.), if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please make an appointment or email me prior to September 6, 2016.

Course Project
The project will consist of a written research proposal and a pre-recorded, oral presentation on a topic selected by the student and approved by the instructor. Project presentations will be recorded and posted to a private channel on YouTube during the last few weeks of the semester. The following deadlines will be followed to ensure the successful completion of the project proposals:

October 20	Proposal topic due (one paragraph describing the general topic area and stating why the topic is of interest) **Your proposal should address the application of nanotechnology to address sustainability issues. A key aspect will be to explicitly consider how you will quantify sustainability.**
November 8-16	Submit draft proposals for feedback.
November 29	Revised (final) proposals due (12 point font, 1 inch margins, 1.5 inch spacing, maximum **10 pages** of text plus one page abstract, list of references).

Course Presentations – Description
Each of you will be required to prepare and record a Powerpoint (or Keynote if you are a Mac person) presentation of 8-10 minute duration. These presentations should be of near-professional quality (go and visit the folks in TLOS for help if necessary) and should address the 'big picture' problem that your proposal seeks to solve.

The presentation at a minimum should convey the following information:

1) What is the key problem you want to address?
2) In very general terms, what are the hypotheses directing your effort?
3) How will you test your approach?

This presentation is an important component of the project and should be taken seriously.

Schedule

Days	Week	Discussion Topic	Reading Assignment
Aug. 23,25	1	Nanotechnology for sustainability A Framework for Sustainability	MCA – Chapters 1&2, London Case Study Little et al. *ES&T*, 2016, Vol. 50, pp. 6830-6845.
Aug. 30, Sept. 1	2	Dynamics of Social-Environmental Systems *Planetary Boundaries*	MCA – Chapters 3&4 Rockström et al. *Nature*, 2009, Vol. 461, pp. 472-475. Steffen et al. *Science*, 2015, Vol. 347, pp. 737 + full article
Sept. 6, 8	3	Governance of Social-Environmental Systems *Rating Systems –*	Suh et al. *ES&T*, 2014, Vol. 48, 2551-2560.
Sept. 13, 15	4	No Class Sept. 13 *Ecological Footprint –* *Process LCA –*	
Sept. 20, 22	5	No Class Sept. 20 *Economic Input-Output LCA –* *MFA/Industrial Metabolism*	
Sept. 27, 29	6	No Class Sept. 27 Systems Dynamics – Linking Knowledge with Action	MCA – Chapters 5&6
Oct. 4,6	7	Green Chemistry & Green Engineering	Anastas and Eghbali, *Chem. Soc. Rev.*, 2010, Vol. 39, pp. 301-312 Hutchison, *ACS Nano*, 2008, Vol. 2, 395-402.
Oct. 11, 13	8	Sustainable Nanomaterial Design Nanomanufacturing	Gilbertson et al. *Chem Soc. Rev.*, 2015, Vol 44, 5758-5777. Liddle and Gallatin, *ACS Nano*, 2016, Vol. 10, 2995-3014.
Oct. 18, 20	9	Nanotechnology for Food Sustainability	
Oct. 25, 27	10	Nanotechnology for Water Sustainability	
Nov. 1,3	11	Nanotechnology for Energy Sustainability	
Nov. 8, 10	12	Nanotechnology for _____ Sustainability	
Nov. 15, 17	13	Nanotechnology for _____ Sustainability	
Nov. 29, Dec. 1	14	No class – work on Video Projects	
Dec. 6	15	No class – work on Video Projects	