ENRGYEGR 490K

Bioenergy

Fall 2014

Dates / contact hours: 300 contact minutes per week for seven weeks
Academic Credit: 1 course
Areas of Knowledge: QS
Modes of Inquiry: STS
Course format: lecture (some sessions may be short labs or hands-on activities, field trips planned, see text for details)

Instructor's Information

Marc Deshusses, Professor and Director of the Energy Engineering Program, Dept. of Civil and Environmental Engineering, 127C Hudson Hall; Box 90287, Duke University, Durham, NC 27708. (919) 660-5480; (919) 660-5219 FAX. marc.deshusses@duke.edu

Prerequisite(s), if applicable

BIOLOGY 201L, MATH 216 or consent of instructor (Basic biology, Math through differential equations are required).

Course Description

Overview of biologically-based processes for biofuel production, energy production and CO_2 capture. Includes fundamental principles, review of the state of the art, design and economics, and future perspectives of current and emerging biologically-based processes in the energy sector. This includes bioethanol, bioelectrical systems, methane and hydrogen production, microalgae, biofuel synthesis and bio-based processes for CO_2 capture.

Course Goals / Objectives

The objectives of this course are to develop students' ability to:

- integrate fundamental biology principles into bioenergy processes
- to demonstrate competence in synthesizing knowledge from multiple disciplines,

- to develop and evaluate bioenergy design solutions and understand their environmental impacts.

Through field trips and case studies, students will acquire critical experience in bioenergy systems, while reinforcing theoretical concepts learned during formal lectures.

Required Text(s)/Resources

Biomass to Renewable Energy Processes, by J. J. Cheng, CRC Press, 2009 (ISBN 978-1420095173)

Recommended Text(s)/Resources

Optional texts:
Environmental Biotechnology: Principles and Applications, by Bruce Rittmann and Perry McCarty, McGraw-Hill, 2000 (ISBN: 0-07-118184-9)
and
Biofuels Engineering Process Technology, by Caye Drapcho, John Nghiem and Terry Walker, McGraw-Hill, 2008 (ISBN 978-0071487498)

Additional Materials (optional)

None

Course Requirements / Key Evidences

Students will reach course objectives by attending lectures, conducting in class exercises, both individual and in groups (e.g., practice problem solving), reading assignments and homework. The course includes one mid-term exam, one final exam, and tentatively two field trips (tentatively ~1/2 day each field trip). Depending on local constraints, the course will include 1-3 laboratory or hands-on activities related to the class subject.

Technology Considerations, if applicable

Some lectures will involve basic AV (projector). If available, Sakai or a similar platform will be used to distribute handouts, post assignments and solutions, email students, etc. Selected assignment will require computer use (e.g., for spreadsheet, or specific calculations).

Assessment Information / Grading Procedures

Grading will be as follows:
Assignments: 20%
Mid-term: 20%

Laboratory exercises, mini project: 20%
Final: 40%

Diversity and Intercultural Learning (see Principles of DKU Liberal Arts Education)

The course is technical in nature and is not focused on addressing the cultural diversity of students or fostering intercultural learning. Team-based exercises and interactive activities will promote communication and exchanges among all participants.

Course Policies and Guidelines

- Academic integrity: follow Duke University procedures
- Attendance: required
- Attention to assignment deadlines: late homework not accepted
- Make-up work: to be discussed on case to case basis
- Appropriate or inappropriate use of cell phone, laptop, or other technology during class: no phone, laptop accepted for class use only

Tentative Course Outline or Schedule

Course outline (tentative number of lectures)

1. Basic microbiology, stoichiometry and thermodynamics of biotransformation (2)
2. Broad overview of bioenergy techniques, legal and political issues, environmental implications (2)
3. Bioethanol (4)
   -basic principles, biological kinetics and yields
   -design, life cycle analysis and environmental implications
   -feedstocks, crop improvements
   -high value-added co-products and downstream processes for product recovery
   -state of the art and emerging applications
4. Bioelectrical systems (microbial fuel cells, microbial electrolysis cells, other bioelectrical) (2-3)
   -basic principles
   -state of the art
   -design, life cycle analysis and environmental implications
   -emerging bioelectrical systems
5. Anaerobic digestion and biomethanation (2)
   -basic principles and applications, biological kinetics and yields
   -state of the art, performance, limits, and emerging applications
   -design, economics and performance
6. Biohydrogen (2)
   -basic principles, biological kinetics and yields
   -state of the art, cell engineering and emerging applications
   -design, life cycle analysis and environmental implications

7. Algae, microalgae and photosynthetic systems for biofuel production and CO_2 capture (2-3)
   -basic principles, biological kinetics and yields
   -state of the art and emerging applications
   -design, life cycle analysis and environmental implications
8. Hybrid biobased-thermochemical systems (1-3)

Post / course codes pending
18 February 2014