**Joan Richmond-Hall, Ph.D.**

GRE223

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**MEC 3040: Bioenergy Fall 2016**

This course provides an overview of bioenergy technologies that can be used to replace current fossil-fuel-based heating systems while contributing to the production of renewable electricity and transportation fuels. Solid, liquid, and gaseous biofuels are introduced, though the course focuses on wood and grass biomass and anaerobic digestion of organic wastes. A variety of feedstock resources, processing, and characterization methods are covered along with various systems used for energy conversion by combustion/oxidation. Policy, permitting, transportation, economics, nutrient recovery, carbon cycling, and life cycle analysis are compared and contrasted. Case studies focus on systems installed in Vermont.

3 credits: 2 hours lecture + 2 hours lab

**Required text**

Dahiya, A (ed) (2015) Bioenergy: Biomass to biofuels, Academic Press, Waltham, MA  
ISBN: 978-0-12-407909-0

**Suggested resources will be on reserve in the library or are referenced and linked**

Boyle, G., Everett, B., Ramage, J. (2003) Energy systems and sustainability: power for a sustainable future, The Open Univesity, UK  
ISBN: 978-0-19-926179-6

Boyle, G. (2004) Renewable energy: power for a sustainable future, Oxford University Press, UK

ISBN: 0-19-926178-4

Rosillo-Calle, F, Johnson, F.X. (2010) Food versus fuel: an informed introduction to biofuels. Zod Books, London & New York

Available on-line

BIOEN 1 - 4: Bioenergy & sustainability course series (March 2012)

fyi.uwex.edu/biotrainingcenter

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| **Week** | **Topic** |
| 1 | **Introduction to bioenergy** (chapters 1, 2, 3)  *Lab: Tour of campus for bioenergy facilities equipment* |
| 2 | **Basics of anaerobic digestion** (17, 18)  *Lab: Creating a systems diagram for VTCAD* |
| 3 | **Factors affecting AD & types of system design** (17, 18)  *Lab: Setting up ball-jar digesters in incubators with a variety of feedstock* |
| 4 | **AD feedstock: energy values, C:N ratios, & prediction of biogas production** (18, 19)  *Lab: Using databases & spreadsheet models to predict energy output of AD diets* |
| 5 | **AD feedstock & regulations**  *\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_* |
| 6 | **AD case studies & future directions** (19)  *Lab: guest speaker: Dave Dunn* |
| 7 | **Biomass: introduction to wood & grass** (4, 5, 7)  *Lab: Measurement of grass density & wood lot evaluation*  *Or field trip to RUHS wood chip facility* |
| 8 | ***Harvesting & processing biomass feedstock*** (4, 5, 7)  *Lab*: *Prep of feedstock materials for pelletizer* |
| 9 | **Combustion systems and biomass heat vs. co-gen** (4, 5, 6)  *Lab:* *Pelletizing biomass feedstock* |
| 10 | **Bio-oil & biodiesel introduction** (28, 34, 7, 34, 11)  *Lab: Evaluation and grinding of oilseeds* |
| 11 | **Biodiesel processing and fuel standards** (28, 21, 29, 20, 8, 32, 34)  *Lab:* *Filtering and dewatering of fresh & waste oils; viscosity* |
| 12 | **Biodiesel economics, enviro impacts, LCA & health effects** (31, 9, 36, 35, 13, 15, 33)  *Lab:* *Biodiesel synthesis & washing* |
| 13 | **Life-cycle analysis & the integrated bio-refinery model** (38)  What is LCA and how is it assessed? What’s the bio-refinery model and why it a biomass goal?  *Lab: Hands-on experience with LCA* |
| 14 | **Bio-energy opportunities** (37)  Entrepreneurial opportunities in bioenergy in Vermont  *Lab: Presentation of case studies of growing companies and organizations* |
| 15 | ***Cumulative FINAL EXAM*** |

**Grading policy:**

Exams = 10% each (total 30%)Cumulative Final Exam = 10%\*

Take-home Quizzes = 15%  
Homework = 15%

Lab Reports or Exercises = 15%

Paper/presentation = 15%

**Due dates and grading notes:**

* ***No*** late work will be accepted. However, acknowledging that we can all have a bad day, I will drop one zero for the semester.
* Homework problems are due at the next class meeting.
* Lab reportsare due at our next lab meeting (1 week later) and are accepted only 2 days after this due date; grades drop by 3.3 points per day for each of those two late days.
* **Quizzes** are take-home. Make up quizzes are not given but you’ll generally have at least 2-3 days to complete each quiz. I’ll drop the lowest quiz grade of the semester only if it is not a zero.
* **Make-up exams** will be provided if you have a valid reason and if you contact me before the exam or immediately after the exam.
* You may replace you hourly exam grades with your grade for the corresponding section of the **cumulative** **final exam**, if the latter grade is higher. However, zeros are not replaced so you should plan to take each hourly exam.
* **Papers / presentations** must include references and use a recognized citation system.

**Grading scale:** A+ 97 – 100 C+ 77 – 80

A 94 – 96 C 74 - 76

A- 91 – 93 C- 71 - 73 B+ 87 – 90 D+ 67 - 70

B 84 – 86 D 64 - 66

B- 81 – 83 D- 61 – 63

F 0 - 60

**FINAL NOTE:**Students with disabilities, whether physical, psychological, or learning, who believe that they may need accommodations in this class are encouraged to contact the Learning Specialist as soon as possible to ensure that such accommodations are implemented in a timely fashion. Please meet with Robin Goodall to verify your eligibility for accommodation and/or academic assistance related to your disability. She can be found in the second floor atrium of Conant, at extension 1278, or by email (rgoodall@vtc.edu).