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NRGY 244.01: Biorenewable Energy Resources

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Course Title: BIORENEWABLE RESOURCES NRGY 244**Course Description:**

NRGY 244 Biorenewable Resources (3 credits) investigates the physical nature of various biomass resources and the technologies currently employed to produce, harvest, refine and convert these into energy, feedstocks and other useful products.

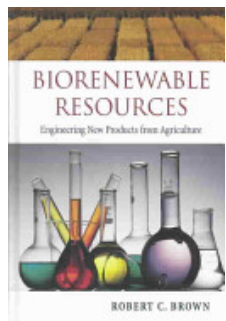
Course Overview:

Plants, both terrestrial and aquatic, macro and microscopic, inhabit most regions of the globe and thrive by capturing some of the limitless energy of the sun. This solar energy stored within plants can be harnessed to help fuel mankind's industry. Since biomass is ubiquitous and renewable, it could potentially provide a significant share of the world's energy needs. There are significant hurdles to overcome, however, as cultivating and processing

biomass can be expensive. Also, since biomass is hydrocarbon-based, its utilization will generate carbon dioxide, a greenhouse gas. This class will broadly investigate the issues surrounding biorenewable resources and the technologies that are currently being employed.

Prerequisites:

Integrated Physical Sciences (SCN 175N), Intro to Energy Systems I & II (NRGY 101 & 102) or equivalents with instructor's permission. This class assumes participants are familiar with basic mathematical, chemical and physical science concepts which will be needed in the homework assignments.

Textbook:

Biorenewable Resources Engineering New Products from Agriculture, 1st Ed. (2003), by Robert C. Brown, Wiley-Blackwell Publishing ISBN 0-8138-2263-7. The Missoula College Bookstore should have new and used copies available prior to class. The bookstore charges full List price of \$99.95 for new copies and \$75 for used copies. As of mid-January, 2016, Amazon had new/used copies for under \$10! The Missoula College library used to have one copy available.

Course Contributions to Program Objectives:

This course helps satisfy the following objectives of the Energy Technology Program:

1. Understand the basics of energy production, delivery, consumption, and waste disposal.
2. Comprehend traditional, alternative, and sustainable energy production technologies.
3. Evaluate energy production sites.
4. Design, install, maintain, and manage energy systems.
5. Assess societal, economic, environmental, ethical, and legal impacts of energy systems.

As an upper level course in the Energy Technology Program, more computational rigor will be required from students and the homework problems will be designed to develop these skills. Also, at this point in the student's studies, practical applications and the synthesis of knowledge and acquired skills is very important and that is the focus of the field trip and term paper. Students must investigate, select, visit, interview and report upon a biorenewable project of their choosing.

Course Outcomes:

1. Broad comprehension of biorenewable resources and the conversion technologies used.
2. Knowledge of the chemical and physical foundations of the biomass industry.
3. Field experience of a commercial biomass facility.
4. Environmental assessment of biomass technologies.
5. Economic considerations of the biomass industry.

Important notice for this web-based class:

With the exception of a field trip requirement, this class is completely web-based. Students are required to have the necessary computer knowledge and manipulation skills. Students should consult the UM Student [On-line 101 webpage](#) to gauge how successful the student may be in the on-line environment. On-line classes are a uniquely different learning experience that demands sufficient student self-motivation. The class will be paced; that is the instructor will only make available instructional material and tests as the class advances along as a unit. Older material may be removed and will be inaccessible.

Students MUST log in to this class and report your presence to the instructor within the first week of class. Assignments will be due during the first week of class and are structured to be due on a given day each week. Email correspondence will be only through official UM email addresses. Students should consult the web course daily for any new announcements, assignments, last-minute changes, etc. I try to make all reasonable accommodations to students with unavoidable schedule conflicts, but you must inform me **IN ADVANCE** about any other issue that impedes your progress through the class. Once the class completes exams or homework problems, I will post feedback in a public announcement and at that point, it will not be possible to make-up for the exam or assignment.

Drop/Add Policy:

[Click here](#) for university policies and procedures.

Academic Honesty Policy:

All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University.

All students need to be familiar with the Student Conduct Code. The Code is available to review online [here](#).

Students with disabilities

Students with disabilities will receive reasonable accommodations in this online course. To request course modifications, please contact me as soon as possible. I will work with you and Disability Services in the accommodation process. For more information, visit the [Disability Services website](#) or call 406.243.2243 (Voice/Text); videophone 406-203-0591 for calls from Montana phone numbers or 877-890-6935 for calls from out of state numbers.

Topics:

UNIT 1. INTRODUCTION.

- 1.1 Definitions
- 1.2 History
- 1.3 Why Biomass
- 1.4 Challenges

UNIT 2. FUNDAMENTAL CONCEPTS IN UNDERSTANDING THE BIOMASS INDUSTRY.

- 2.1 Introduction
- 2.2 Thermodynamics
- 2.3 Organic chemistry
- 2.4 Chemistry of plant matter

UNIT 3. THE BIOMASS RESOURCE BASE.

- 3.1 The resource
- 3.2 Properties
- 3.3 Yields
- 3.4 Size of resource base

UNIT 4. PRODUCTION OF BIOMASS RESOURCES.

- 4.1 Introduction
- 4.2 Herbaceous crops
- 4.3 Woody crops
- 4.4 Storage
- 4.5 Transgenic crops

UNIT 5. PRODUCTS FROM BIOMASS RESOURCES.

- 5.1 Introduction
- 5.2 Bioenergy
- 5.3 Transportation fuels
- 5.4 Chemicals
- 5.5 Fibers

UNIT 6. CONVERSION OF BIOMASS RESOURCES INTO HEAT AND POWER.

- 6.1 Introduction
- 6.2 Direct combustion
- 6.3 Thermal gasification
- 6.4 Anaerobic digestion

UNIT 7. PROCESSING OF BIOMASS RESOURCES INTO CHEMICAL AND FUELS.

- 7.1 Introduction
- 7.2 Fermentation of sugars and starches
- 7.3 Conversion of lignocellulosic feedstocks to sugar
- 7.4 Lipid extracts
- 7.5 Thermochemical conversion
- 7.6 Other processes

UNIT 8. PROCESSING OF BIOMASS RESOURCES INTO NATURAL FIBERS.

- 8.1 Introduction
- 8.2 Mechanical pulping
- 8.3 Chemical pulping
- 8.4 Depithing

UNIT 9. ENVIRONMENTAL ASPECTS.

- 9.1 Introduction

- 9.2 Plants
- 9.3 Production
- 9.4 Processing
- 9.5 Utilization

UNIT 10. ECONOMICS OF BIOMASS RESOURCES.

- 10.1 Introduction
- 10.2 Feedstock costs
- 10.3 Manufacturing costs

Class Flow

Lessons are organized as week-long activities with some taking more than one week to complete. My lesson notes are presented on each unit along with any announcements, assignments (reading, discussion & homework), and quizzes. The class flow will consist of the new lessons usually activated on Fridays, discussion forum posts due on Wednesdays, homework problems due on Fridays and unit quizzes due on Sundays. Assignments are due by 11:55 pm on the given day. Homework should be submitted via the Moodle submission process. You can use a text document or spreadsheet or a scan of handwritten work as long as it's in some typical file format like MS Word, Excel, pdf or txt. Quizzes are usually 10 questions worth 10 points total with a time limit of 35 minutes. There is usually a bonus question thrown in. You can use all academic means at your disposal (book, notes, internet, etc.) but copying others' work or consulting with others will be considered academic dishonesty and subject to disciplinary action. A self-directed field trip is an important part of this class and a term paper based on this experience will be a significant part of your grade. The field trip and term paper are due by the end of Week 10 (see schedule below), which is just prior to Spring Break. On most Thursdays, I will have a face-to-face session at the Missoula College room HB05 from about 5:20 pm until 6:30. This session will focus on problem solving skills and not so much on course content which I comment on in my weekly Lesson Notes. Be sure to check my weekly announcements to see if there is a session scheduled that week. The tables below show how I will grade your assignments:

Paper Grading	Points	% of Grade
Content	40	40%
Grammar (sentence structure, spelling, etc.)	30	30%
Length (1500 to 2000 words – use word count, I do!)	15	15%
References (minimum of 3)	15	15%
Total	100	100%
Discussion Forum Grading		
Content	3	60%
Interaction (responds to at least 2 other posts)	2	40%
Total	5	100%
Homework Grading		
Problem set up (rationale, data organization, flow)	3	60%
Computational correctness	2	40%
Total	5	100%

Late Assignments:

For discussion forums and homework assignments, lose 1 point/day for maximum of 2 days after which assignment will not be accepted. For term paper, lose 5 points/day for maximum of 6 days after which assignment will be refused. This does not apply to excused situations.

Grade Determination:

	Points	% of Grade
Unit Exams (12 exams, 10 pts. each)	120	32.4
Discussion Postings (12 postings, 5 pts. each)	60	16.2
Homework Problems (12 probs., 5 pts. each)	60	16.2
Field Trip and Class Paper	100	27.1
Final Comprehensive Exam	30	8.1
Total	370	100.0

Grade	Total Points
A	$333 \leq x$
B	$296 \leq x < 333$
C	$259 \leq x < 296$
D	$222 \leq x < 259$
F	$x < 222$

Course Schedule:

Week	Monday's Date	Learning Unit	Discussions Due by 11:55 pm	Homework Due by 11:55 pm	Unit Exams Due by 11:55 pm
1	1/25	Class Introductions	1/27	1/29	1/31
2	2/1	Biorenewables Intro	2/3	2/5	2/7
3	2/8	Scientific Fundamentals I	2/10	2/12	2/14
4	2/15	Scientific Fundamentals II	2/17	2/19	2/21
5	2/22	Resource Base	2/24	2/26	2/28
6	2/29	Production	3/2	3/4	3/6
7	3/7	Products	3/9	3/11	3/13
8	3/14	Heat & Power	3/16	3/18	3/20
9	3/21	Chemicals	3/23	3/25	3/27
10	3/28	Field Trip/Term Paper	None	None	Term paper due midnight 4/3
11	4/4	Spring Break	None	None	None
12	4/11	Fibers	4/13	4/15	4/17
13	4/18	Environmental Impacts	4/20	4/22	4/24
14	4/25	Economics	4/27	4/29	5/1
15	5/2	Review	None	None	None
16	5/9	Finals Week	None	None	Final due by 5/13

Prepared by: Brian P. Kerns**Revised:** January 20, 2016