Course Number: FOPR 5050/6050  
Course Title: Biomass Processing Chemistry and Bioenergy 
Course Instructor: Maobing Tu  
Credit Hours: 3; 3 hours lecture 
Prerequisites: CHEM 1010 or higher 

Course Description 
This course introduces biomass fiber morphology, cellulose, hemicellulose and lignin chemistry and their chemical analyses. It also covers biomass pretreatment/fractionation, enzymatic hydrolysis of lignocellulose and biochemical conversion of hydrolysate to ethanol or butanol. Bioenergy and bioproducts from woody biomass will be emphasized. 

Course Objectives 
1. Students will develop a basic understanding of wood chemistry and forest biotechnology. 
2. Gain a profound knowledge of the chemistry of cellulose, hemicellulose and lignin and their chemical reactions in pulping and bleaching processes. 
3. Develop a basic understanding of bioconversion process for biofuels and bioproducts from woody biomass. 
4. Develop a basic understanding of wood fibers and biosynthesis of wood constituents. 
5. Develop a basic understanding of biotechnology application in forest industry. 

In addition, graduate students will: 
1. Develop professional oral and written communication skills necessary within the discipline. 
2. Gain an advanced knowledge of wood chemistry focused on biomass processing. 
3. Understand the current state of technical issues related to bioconversion of biomass to liquid biofuels. 

Textbook or Assigned Readings 
Reference book
Monica EK; Goran Gellerstedt; Gunnar Henriksson 2007 Wood Chemistry and Wood Biotechnology (Publisher: Stockholm: KTH)

Grading and Evaluation Procedures
For undergraduate students, the two examinations during the semester will each constitute 25% of your final grade. The final examination will account for 40% of your grade. The attendance will be 10% of your final grade.

For graduate students, the two examinations during the semester will each constitute 15% of your final grade. The final examination will account for 40% of your grade. The attendance will be 10% of your final grade. A research paper and oral presentation will be 20% of your final grade. Fifty percent of the final exam will be cover the material in the last third of the course and 50% will be comprehensive.

Make-up exams will only be given only with a valid university excuse (dire and documented emergencies). This means a Doctors’ statement or other documentation must be provided. All make-up exams will be given on one of the two designated makeup days. The student is responsible for informing the instructor prior to missing an exam no later than one week after the exam official date.

Method of Evaluation for FOPR 5050 (Grading):
10% Attendance
50% Exams (2 exams)
40% Final Exam

Method of Evaluation for FOPR 6050:
10% Attendance
30% Exams (2 exams)
20% Research Paper (Presentation)
40% Final Exam

Grade Scale
A=100-90
B= 89-80
C= 79-70
D= 69-60
F= 59-0
Policies

Students with Disabilities

Students who need special accommodations should make an appointment to discuss the Accommodation Memo during my office hours as soon as possible. If scheduled office hours conflict with classes, please arrange an alternate appointment time. If you do not have an Accommodation Memo, but need special accommodations, contact The Program for Students with Disabilities in 1244 Haley Center (844-2096 V/TTY)

Academic Honesty

Auburn University expects students to pursue their academic work with honesty and integrity. Violations of the Student Academic Honesty Code and potential sanctions are detailed under Title XII of the SGA Code of Laws, which can be found in the Tiger Cub.

Justification for Graduate Credit

Additional readings for graduate students will include the topics of “improve wood properties through genetic engineering” and “Renewable & alternative energy from woody biomass”

Graduate students will have to learn and understand the fundamentals and application of wood chemistry and forest biotechnology. In addition to the knowledge and skills gained from lectures, graduate students are required to dive deeper into and report on some of the theoretical aspects of these subjects via a thorough search of the literature. In this connection, graduate students will be required to write a research paper about genetic modification of trees or forest biorefinery, and give an oral presentation in class following a seminar format. This is intended to enhance their ability to be good scientists with excellent communication skills and solid knowledge in are of forest products. The graduate students are expected to understand what are the potentials and bottlenecks for biotechnology application in wood properties improvement, and to comprehend the current state of technical issues in the biofuels production from woody biomass and their potential environmental impact.
Outline of Course Content

Chapter 1 Basic biomass properties (week 1)
  1. Cell wall and plant anatomy
  2. Fiber morphology

Chapter 2 Basic Carbohydrate chemistry (week 2)
  3. Structure and stereochemistry
  4. Reduction of monosaccharide
  5. Oxidation of monosaccharide
  6. Oligosaccharides and Polysaccharides

Chapter 3 Chemistry of polysaccharides (week 4-5)
  7. Structure and properties of cellulose
  8. Addition and substitution reactions
  9. Structure and properties of hemicelluloses
  10. Hydrolysis of cellulose by acid and enzyme
  11. In-class Exam I

Chapter 4 Chemistry of lignin (week 5-6)
  12. Biosynthesis of lignin
  13. Structure and properties of lignin
  14. Isolation and application of lignin
  15. Chemistry of extractives

Chapter 5 Pulping technology (week 7-8)
  16. Mechanical pulping and chemical pulping
  17. Sulfate Process (Kraft pulping)
  18. Sulfite Process and bioethanol production

Chapter 6 Biomass pretreatment/fractionation (week 9-10 Guest speakers)
  19. Dilute acid pretreatment
  20. Steam explosion pretreatment
  21. Ammonia fiber explosion (AFEX) pretreatment
  22. Organosolv pretreatment
  23. In-class Exam II

Chapter 7 Enzymatic hydrolysis of lignocellulose (week 11-12)
  24. Cellulases from *Trichoderma reesei*
  25. Cellulosome cellulases of *Clostridium cellulovorans*
  26. Enzymatic hydrolysis modes for cellulose

Chapter 8 Biochemical conversion of lignocellulose to alcohol (week 13-14)
  27. Separate hydrolysis and fermentation process (SHF)
  28. Simultaneous saccharification and fermentation process (SSF)
  29. Consolidated Bioprocess (CBP)
30. Pentose fermentation by yeast and bacteria

**Chapter 8 Thermochemical conversion of biomass to liquid fuels** (week 15 Guest speakers)

- 31. Gasification process
- 32. Pyrolysis process of lignocellulose to liquid fuels