

## CHEM 436/636, CPM 436/636, ME 436/636 – Biopolymers and Biocomposites

FALL 2022 (3.0 CREDITS)

### **COURSE PREREQUISITES**

CHEM 122, Junior Standing

### **CLASS TIME**

Tuesday & Thursday: 11:00 AM – 12:15 PM, CIE Room 207

### **INSTRUCTOR**

Dr. Chad Ulven, Professor of Mechanical Engineering  
Office: Dolve Hall 111F, NDSU  
Office Hours: Tuesday, Wednesday 11:00am-12:30pm  
Phone: 701.231.5641  
Email: [Chad.Ulven@ndsu.edu](mailto:Chad.Ulven@ndsu.edu)

Contact information and office hours for other teaching faculty can be found on the courses Blackboard website as well as their personal websites.

### **BULLETIN DESCRIPTION**

Structure/properties/synthesis of biopolymers, biomaterials and engineered biocomposites derived from plant-based materials. An interdisciplinary course designed for graduate and undergraduate students. Introduction to science and engineering of converting biorenewable resources into novel biobased materials and products. Introduction to principles and concepts critical to successful design of polymeric biomaterials, coatings, and biocomposites. Understanding environmental impact through life cycle analysis.

### **DETAILED COURSE DESCRIPTION**

This course introduces students to fundamental chemistry of biopolymers, and structure/properties of biomaterials. Basic synthesis and production of biopolymers, engineering of composites from these biopolymers or plant-based materials. Students will learn about the biomaterial sources, synthesis, physico-chemical properties, applications, degradation of biopolymers and their environmental impact through life cycle analysis. They will also learn about the use of biopolymers, plant-based materials including cellulosic and nanomaterials, agricultural fibers in composites. Using principles of polymer science, mechanics, and adhesion, students will learn to engineer and predict properties of various bio-based composites including nanocomposites, biofiber-plastic composites, and adhesive-bonded composite panels.

### **COURSE OBJECTIVES**

Broad Course Objectives: The course is intended to give graduate and undergraduate student an overall understanding of biobased material, bioproducts, new applications, and impact of these products on the environment. This course is intended to create a detailed understanding of the importance of biobased materials in the sustainable bioeconomy.

The specific objectives are:

- (a) To learn basic building blocks of biobased materials, their structure, properties and characterization methods.
- (b) To get insight into the synthesis and production of biomaterials.
- (c) To create understanding how cellulosic and biopolymer resins can be used to create sustainable engineered products.
- (d) To learn how to design biocomposites from natural fibers and biopolymeric materials
- (e) To create an understanding of the impact of biopolymers, and biobased materials on society and the environment.

### **COURSE RESOURCES**

Textbook: No required textbook. Lecture notes, reading material and supplementary information will be provided by the instructors. Regular handouts/Blackboard materials will also be provided.

### **COURSE SCHEDULE/OUTLINE**

Schedules/outlines may subject to changes based on the actual process & student backgrounds.

#### **INSTRUCTOR LECTURE DATES - Biopolymers and Biocomposites Fall 2022**

<b>Date</b>	<b>Topic</b>	<b>Instructor</b>	<b>Lecture Dates</b>
Lecture 1	Introduction to the course	Dr. Ulven	<b>August 23</b>
Lecture 2	Comparison of fossil fuel and biomass-derived chemicals	Dr. Sibi	<b>August 25</b>
Lecture 3	Feedstock chemicals from biomass	Dr. Sibi	<b>August 30</b>
Lecture 4	Synthesis of monomers from biomass	Dr. Sibi	<b>September 1</b>
Lecture 5	Synthesis of monomers from biomass	Dr. Sibi	<b>September 6</b>
<b>Lecture 6</b>	Topic Recap / Quiz	Dr. Sibi	<b>September 8</b>
Lecture 7	Sustainability I	Dr. Grewell	<b>September 13</b>
Lecture 8	Sustainability II	Dr. Grewell	<b>September 15</b>
Lecture 9	Extrusion	Dr. Grewell	<b>September 20</b>
Lecture 10	Injection Molding	Dr. Grewell	<b>September 22</b>
Lecture 11	Protein Based Plastics	Dr. Grewell	<b>September 27</b>
<b>Lecture 12</b>	Topic Recap / Quiz	Dr. Grewell	<b>September 29</b>
Lecture 13	Major Classes/Uses of Petrochemical Polymers	Dr. Webster	<b>October 4</b>
Lecture 14	Cellulose-based resins/materials	Dr. Webster	<b>October 6</b>
Lecture 15	Commercial Biobased Polymers	Dr. Webster	<b>October 11</b>
Lecture 16	Emerging Biobased Polymers	Dr. Webster	<b>October 13</b>
Lecture 17	New Biobased Polymers	Dr. Webster	<b>October 18</b>
<b>Lecture 18</b>	Polymer degradation / Topic Recap / Quiz	Dr. Webster	<b>October 20</b>
Lecture 19	Introduction to bast natural fibers	Dr. Ulven	<b>October 25</b>
Lecture 20	Surface treatment of bast fibers	Dr. Ulven	<b>October 27</b>
Lecture 21	Processing of short and long fiber composites	Dr. Ulven	<b>November 1</b>
Lecture 22	Properties of thermoset bast fiber composites	Dr. Ulven	<b>November 3</b>
Lecture 23	Properties of thermoplastic bast fiber composites	Dr. Ulven	<b>November 8</b>
Lecture 24	Topic Recap / Quiz	Dr. Ulven	<b>November 10</b>

Lecture 25	Introduction to Sustainability of Biobased Materials	Dr. Pourhashem	<b>November 15</b>
Lecture 26	LCA of Biobased Materials I: Concept, Goal & Scope	Dr. Pourhashem	<b>November 17</b>
Lecture 27	LCA of Biobased Materials II: Inventory, Tools & Design	Dr. Pourhashem	<b>November 22</b>
Lecture 28	LCA of Biobased Materials III: computer lab	Dr. Pourhashem	<b>November 29</b>
Lecture 29	LCA Interpretation & Decision Making: challenges and opportunities of biobased materials	Dr. Pourhashem	<b>December 1</b>
<b>Lecture 30</b>	Topic Recap / Quiz	Dr. Pourhashem	<b>December 6</b>

## EVALUATION PROCEDURES AND GRADING CRITERIA

Assessments for the performance of this course includes attendance, homework, assignments, or quizzes, and a term paper (for graduate students only).

The grading of the course will be strictly based on the following:

Grading:		436	636
	Quizzes (5)	50%	45%
	Homework (5)	50%	40%
	Short Paper		15%

A=100-90%; B=89-80%; C=79-70%; D=69-60%; F=59-0%

*For averages falling between the whole numbers, rounding will be as follows: for 0.5 or higher, the average will be rounded up, for lower than 0.5, the average will be rounded down. For example, an average score of 79.6 would be rounded up to 80.0.*

### Important Notes:

- All quizzes, homework, assignments, etc. are to be submitted electronically. You must use a No. 2 pencil or blue/black ink pen when completing any handwritten work, other colored ink will not show up in scans. All work is to be uploaded as a single PDF on BB for the appropriate assignment/quiz/exam, unless instructed otherwise. Free apps for scanning and producing easy to read PDFs with no background around the page(s) include:
  - Adobe Scan (<https://acrobat.adobe.com/us/en/mobile/scanner-app.html>)
  - Microsoft Office Lens (<https://www.microsoft.com/en-us/p/office-lens/9wzdncrfj3t8?activetab=pivot:overviewtab>, also available for Apple products)
  - Tiny Scanner ([https://play.google.com/store/apps/details?id=com.appxy.tinyscanner&hl=en\\_US](https://play.google.com/store/apps/details?id=com.appxy.tinyscanner&hl=en_US), also available for Apple products)
- Assignments will be given on Tuesday after class and they are due the following Tuesday at the beginning of the class. No late assignments will be graded. If a student is unable to turn in the assignment on the due date for medical reasons, the instructor must be informed.
- A total of five homework/assignments will be given and all will be considered for final grade.
- Five quizzes will be given. Make-up quizzes will be given only in the case of 1) a doctor certified medical excuse, or 2) prior instructor approval.

5. A term paper will be an individual assignment for graduate students enrolled in this class. They will be required to pick a topic outside their department focus. They are encouraged to select a topic in consultation with an instructor. The term paper will be presented in the class during the final exam week. For the term paper, evaluation forms will be distributed to the classmates for the performance evaluation, which will be considered 15% of the final grade. Undergraduate students will be required to attend the term paper presentations.

### **HEALTH AND SAFETY EXPECTATIONS**

While masks are not required as we begin the 2022 fall semester, NDSU administration has determined that faculty may request mask use in their classroom. In this class, I ask that **you wear a mask** to help protect my health and the health of your peers.

Where possible, please spread out within the classroom, including not sitting in the first row of the classroom, to maximize social distancing.

### **ATTENDANCE EXPECTATIONS**

Please **do not come to class** if

- you are feeling ill, particularly if you are experiencing COVID-19 symptoms, or
- you are infected during your five-day isolation period.

**You will still need to complete the assignments, exams, reading, etc. necessary to meet class learning objectives. You can complete missed work** by contacting the instructor and making arrangements.

### **ATTENDANCE STATEMENT**

According to NDSU Policy 333 ([www.ndsu.edu/fileadmin/policy/333.pdf](http://www.ndsu.edu/fileadmin/policy/333.pdf)), attendance in classes is expected.

Veterans and student service members with special circumstances or who are activated are encouraged to notify the instructor as soon as possible and are encouraged to provide Activation Orders.

### **AMERICAN DISABILITIES ACT FOR STUDENTS WITH SPECIAL NEEDS STATEMENT**

Any students with disabilities or other special needs, who need special accommodations in this course, are invited to share these concerns or requests with the instructor and contact the [Disability Services Office \(www.ndsu.edu/disabilityservices\)](http://www.ndsu.edu/disabilityservices) as soon as possible.

### **APPROVED ACADEMIC HONESTY STATEMENT**

The academic community is operated on the basis of honesty, integrity, and fair play. [NDSU Policy 335: Code of Academic Responsibility and Conduct](#) applies to cases in which cheating, plagiarism, or other academic misconduct have occurred in an instructional context. Students found guilty of academic misconduct are subject to penalties, up to and possibly including suspension and/or expulsion. Student academic misconduct records are maintained by the [Office of Registration and Records](#). Informational resources about academic honesty for students and instructional staff members can be found at [www.ndsu.edu/academichonesty](http://www.ndsu.edu/academichonesty).