Syllabus

ABE498/598: Circular Bioeconomy and Resource Recovery

Fall 2026

3 h for Undergraduate, 4 h for Graduate Option

Instructors: Yuanhui Zhang, Founder Professor
Dept. of Agricultural and Biological Engineering

Objectives:

The overarching objective is to educate next generation of engineers and professionals with a mindset of circular bioeconomy and a skill set to analyze the circularity so that proper resource recovery technology and management can be developed and implemented. Specifically, by completing this course, students are expected to be able to:

1) Understand the fundamentals of a Circular Bioeconomy System (CBS) in terms of its characteristics, pathways, and implications to the environment and the society;
2) Be able to analyze a CBS at different scales and specific settings using models such as Circularity Indices to quantify the degree of circularity of a bioeconomy system, and evaluate the effect of a particular technology or management on circularity;
3) Be able to identify and design different resource recovery technologies and management practices to improve the circularity of a bioeconomy system.

Class Schedule

3:30 – 4:50 pm, Tuesdays and Thursdays, Room 272, AESB

Class	Date	Topic	Assignment & Discussion Topic
1	8/25	Introduction, Overview of Syllabus and course setting	
2	8/27	Paradigm shift from linear to circular bioeconomy	What are the differences among TEA, LCA and CBS?
3	9/1	Carbon emission and balance (CO2, CH4, fossil fuel supplement), Sectors of buildings, Industry, transportation	What's your definition of Sustainability?
4	9/3	Nitrogen emission and cycle, fertilizer, minerals balance;	How to define and quantify a CBS?
5	9/8	The phylogeny of Circular Bioeconomy Systems; Dimensions of CBS	HW 1: Define and characterize dimensions of a circular bioeconomic system
6	9/10	Scalable models for CBE; focus on quantification –Resource categories	Reading: Circularity Index
7	9/15	Quantifying CBS -- Circularity Index (CI); Analytics of key factors on energy, environment and CBS	Literature reading and discussion: What are missing in CBS approaches?
8	9/17	CI continued – Use CI tool for quantification of Circular Bioeconomy Systems	What's your CBS of concern: Select the project topic
9	9/22	CBS case study – Emphasize on solutions and techno-economic assessment.	HW 2: Quantifying CBS using CI method

10	9/24	Pathway to circularity: 3 Rs -- Reduction Recycle and Reuse	Project topic preview: Instructions and report requirement
11	9/29	3 Rs continued – materials and energy: Landfill, water, energy efficiency	Milestone 1: define CBS boundary of your chosen system
12	10/1	Pathway to circularity – Increase renewable resources production; renewable energy -solar, wind, bioenergy	Literature review: Status and potential of renewable energy
13	10/6	Nitrogen efficiency, phosphorous efficiency	Milestone 2: Define resources type of your chosen CBS
14	10/8	Balancing the demand of food, water and energy and circularity	Literature review: Status of reactive fertilizer and effect on food systems
15	10/13	Other renewable resources, phosphorous, metals	Clarifying CBS of concern and resource types
16	10/15	Pathway to circularity – Resource recovery Focus on bottlenecks	Milestone 3: Data collection for the selected CBS
17	10/20	Resource recovery -- from disposed/biowaste	Summary - Reading literature
18	10/22	Case study 1: Anaerobic digestion	Reading literature
19	10/27	Case study 2: Hydrothermal liquefaction	Reading literature
20	10/29	Case study 3: hydrothermal gasification, carbonization, and pyrolysis	Reading literature
21	11/3	Energy recovery – wasted energy from building	Summarize building energy use and recovery potential in U.S.
22	11/5	Valorization of disposed streams/resources EE-FEWS paradigm	Milestone 4: Data curation and CI calculation
23	11/10	Case study: Valorization of Biowaste	Literature: PECS paper
24	11/12	Carbon recovery efficiency with techno-economic analysis	Case study of TEA analysis in CBS
25	11/17	Energy recovery efficiency with techno-economic analysis	Milestone 5: Graph of circularity and interpretation
26	11/19	Project preview: checking the mass balance and energy balance	
		Thanksgiving Break	
27	12/1	Summary of the CBS projects	Roundtable – Q&A
28	12/3	Presentation of Project (Session 1)	
29	12/8	Presentation of Project (Session 2)	Final project report must be submitted by 12/14

AI Usage Policy:

Students are encouraged to utilize AI for this course with the following requirements:

1) Data used in the project should be either experimentally collected, or collected from credible references such as peer reviewed publications and reports with citation;
2) Final project report must be constructed by the student, with AI-assisted editing and presentation (illustration and description).
3) Citation should conform with the format of a professional journal of your area or your professional society.