Biofuels and Bioproducts Engineering
CBE 494/590
University of Tennessee, Knoxville
Department of Chemical and Biomedical Engineering
Instructor: Abhijeet P. Borole.
Tue, Thu 5:10 PM – 6:25 PM

Description:

The course will cover processes involved in transformation of biomass and other resources into biofuels and bioproducts. This will be an applied course, with focus on existing and upcoming technologies for bioconversion of renewable resources, description of current roadblocks and exposure to future needs. Intended primarily for senior class and graduate students from various disciplines, the course considers the emergence of biofuel/bioproduct engineering as a coherent field of research and practice. It will include a distinctive blend of elements ranging from molecular bioengineering and biotechnology to process design, resource assessment and life-cycle analysis. Biofuels such as ethanol, biodiesel, biohydrogen, and bioelectricity will be covered. A range of bioproducts from low volume, high value products to high volume low value products (biocommodities) will be discussed. Examples are biopolymers, renewable chemicals such as propanediol, lactic acid, etc. Among the biofuels, ethanol production will be the primary example, with coverage including feedstock production and logistics, biomass recalcitrance issues and unit operations within biorefineries. The course will include a few lectures from local experts on specific topics. The course will require the students to present a paper which can be on the general topic of bioproduct/biofuels or very specific targeting a single aspect of bioproduct development. Teams of students with different backgrounds (eg. Molecular Biology and Chemical Engineering or Biosystems Engineering) may jointly propose topics or choose from a list provided by the instructor.

Course contents / topics to be covered:

1. Introduction –
    a) Five core areas to be covered: Bioethanol, biodiesel, biohydrogen, bioelectricity and bioproducts (B^5) with commercial and R&D aspects of each area.
    b) Students will present seminars at the end of the term
2. Corn to ethanol bioindustry
3. Cellulosic bioethanol – biomass feedstocks, biochemical vs thermochemical conversion, unit operations (pretreatment, fermentation, product separation), lifecycle analysis, R&D needs and Bioenergy centers.
4. Fundamental tools or building blocks for creating new and novel biofuels and bioproducts - synthetic biology, omics technologies, etc., e.g. Biobricks.
5. Biodiesel production – feedstocks, conversion via chemical and enzymatic process and their limitations.
6. Biohydrogen production – Fermentation, photobiological, bioelectrolysis process
7. Bioelectricity production via biofuel cells

8. Bioproducts – Propanediol, long chain fatty molecules e.g., surfactants, polymers, biobutanol, higher alcohols, lignin products, etc.
9. Environmental topics of relevance - carbon sequestration, water recycle and reuse
10. Bioethics and policy related to biofuels / bioproducts
11. Expert lectures (from industry professionals and ORNL scientists, scattered through out the course)
12. Student seminars

Course structure:
The course will be presented to enable understanding of current technology, learn about R&D needs, and promote interactive discussion on each of the B^5 topics to generate and discuss new ideas and directions. It will include reading literature reports on each topic and assignments to pursue individual topics of interest to the depth and scope possible during the semester. The student evaluations will rely more on homeworks, reports, and seminar/presentation and less on class exams.

Expert Lectures
1. Biomass feedstock assessment using GIS technology
2. Biomass recalcitrance and deconstruction
3. Consolidated BioProcessing
4. Biodiesel Production
5. Photosystem biomimetic catalysts
6. Bioproducts from renewables (tentative)
7. Biopolicy related to renewable energy and environment (tentative)