Western Engineering

DEPARTMENT OF CHEMICAL AND BIOCHEMICAL ENGINEERING

CBE 4484 – PROCESSES FOR GREEN PRODUCTS

Course Outline Winter 2026

Instructor: Prof. Franco Berruti (ICFAR, TEB 373); Tel. 661-2111 ext 88771; email: fberruti@uwo.ca

Teaching Assistant: TBA

LECTURES:	Mondays/1:30pm-2:30pm UCC 59 Wednesdays/2:30pm-4:30pm UCC 65
LAB or TUTORIAL:	Mondays/3:30pm-4:30pm SEB 1056
PREREQUISITE(s):	CBE 2207, CBE 2224, CBE 3315
CEAB Academic Units:	Engineering Science 100%
TEXT / Course Resources / References	Course slide presentations shared. Uploading the slides to public sites such as YouTube or sharing them with people who are not registered in CBE 4484 is NOT ALLOWED.
DESCRIPTION (50 words max)	This course describes what are green chemicals and products and the main current or potential processes used to produce green chemicals and products. The student should be aware of the issues associated with the production of products from fossil resources, be aware of the current processes that are used on a commercial scale to produce green chemicals and products, their advantages and drawbacks. The students should develop an understanding of the opportunities to transform wastes into resources that can generate both economical and environmental benefits.

General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base		Engineering Tools		Impact on Society	**A**
Problem Analysis	**A**	Individual & Teamwork		Ethics and Equity	
Investigation		Communication		Economics and Project Mgmt.	
Design		Professionalism		Life-Long Learning	

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

Learning Outcomes	(CAEB) Graduate Attribute
Demonstrate ability to formulate a strategy to solve an engineering problem	PA2 (Applied)
Demonstrate understanding of the concept of sustainable design and development	IESE2 (Applied)

Assessment

Name	% Worth	Due Date	Learning Outcomes
Mid Term Exam	30%	February 25, 2026	IESE2
Final Exam	30%	TBA	IESE2
1st Project Report	10%	February 4, 2026	PA2
2nd Project Report	10%	March 4, 2026	
Draft of Final Report	10%	March 18, 2026	
Final Report	10%	March 30, 2026	

EXTRA COURSE INFORMATION

Units
SI units will be used in lectures and examinations.

General Learning Objectives:
• Be introduced to the possible future processes to produce green fuels and chemicals, their advantages and drawbacks.
• Gain knowledge to integrate various processes in a bio-refinery.
• Be aware of the socio-economic and environmental impacts of the various processes.

Specific Learning Objectives:
Introduction: Why we need Green Products. Biomass Resources
At the end of this topic, students should:
• be aware of the environmental and political drivers behind the development of green products.
• have a general knowledge of the processes used to produce fuels, chemicals, and products from fossil resources.
• be aware of the environmental issues associated with these processes.

Biomass/BioFuels Combustion
At the end of this topic, students should:
• know the processes used for the combustion of wood and residues from agricultural, food processing, and municipal waste operations, as well as the processes for the combustion of fuels derived from these feedstocks.
• be aware of the environmental and logistic issues associated with these processes.

Biomass Gasification
At the end of this topic, students should:
• know the processes used to gasify wood and residues from agricultural, food processing, and municipal waste operations.

• be aware of the environmental and logistic issues associated with these processes.

Pyrolysis to Biochar, Bio-oil, and Gas
At the end of this topic, students should:
• understand the processes that are used to pyrolyze biomass.
• be aware of the technical and environmental issues of using raw bio-oils and biochar.

Processing and Refining of Bio-oils and Biochar
At the end of this topic, students should:
• understand how bio-oil can be stabilized and cleaned.
• know how bio-oil can be upgraded into valuable products.
• understand the various applications of biochar.
• know how to transform biochar into higher-value products.

Biodiesel and Renewable Jet Fuel
At the end of this topic, students should:
• know the processes that are used to produce biodiesel.
• know the processes that are used to produce renewable jet fuel.
• understand the social, economic, and political problems associated with the various production schemes.

Processes for Green Carbon and Hydrogen
At the end of this topic, students should:
• know the different types of green carbon.
• know how to produce green carbon and hydrogen from fossil sources and waste plastics.
• know how to produce green carbon and hydrogen from renewable sources.

Bioethanol and Biobutanol
At the end of this topic, students should:
• know the processes that are used to produce bioethanol, including biochemical and thermochemical methods.
• know the processes that are used to produce biobutanol, including biochemical and thermochemical methods.
• understand the social, economical and political problems associated with the various production schemes.

Biogas by Fermentation
At the end of this topic, students should:
• know the various fermentation processes that can be used to transform agricultural, industrial and municipal waste into biogas.
• understand the various issues associated with the purification and use of biogas as a feedstock for the production of high value chemicals and products.

Syngas and Hydrogen Production. Syngas Conversion to Clean Chemicals
At the end of this topic, students should

• understand the processes that are used to generate syngas.
• know the processes that are used for hydrogen production from syngas.
• know the main processes that are used to convert syngas to chemicals.

Biorefining: Product Separation and Purification
At the end of this topic, students should:
• understand the processes that are used to extract and purify green chemicals and products, with a stress on green processes.
• know the characteristic features of currently produced and novel biomaterials and the processes that are used to produce them.

Green Chemistry Separations: Extraction and Purification of Green Chemicals from Renewable Resources
At the end of this topic, students should:
• know the major green chemicals that are obtained from renewable resources.
• understand the processes that are used to produce chemicals from renewable resources.

Economics and Social Impact. Government Policies
At the end of this topic, students should:
• know how to evaluate the economics and social impact of green chemicals.
• be aware of the major, relevant government policies.

Circular Economy of Waste Plastics
At the end of this topic, students should:
• know the circular economy principles can be applied to waste plastics.
• understand the processes that are used to produce valuable chemical products from waste plastics

I. Missed/Late Accommodation Policy

1. Students missing a test/assignment/lab or examination you will report the absence by submitting Academic Consideration Request form through STUDENT ABSENCE PORTAL.
2. **Documentation must be provided as soon as possible.**

II. Exam Accommodation

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, headache, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department and the Associate Dean and in order to apply you must submit an the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
   PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

III. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (prior to the due date of the assignment).
2. Be prepared to submit the Academic Consideration Request Form and provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. The assignments/projects deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, your written assignments and projects have a no-questions-asked 2-day grace period. This means that you can submit any of these assignments up to 2 days past the posted deadline without penalty. As such, requests for academic consideration for assignments and projects will be denied.
5. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.
   Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

IV. Medical Accommodation

1. Requests for Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Requests for academic consideration must include the following components:
   a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
   b. Medical note
   c. Indication of the course(s) and assessment(s) affected by the request
   d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline.
   Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Registration.

6. An instructor may deny academic consideration for any assessment that is not required in the calculation of the final grade (e.g., “8 of 10 quizzes”). Assessment flexibility must be indicated on the course outline.
7. An instructor may deny academic consideration relating to the timeframe submission of work where there is already flexibility in the submission timeframe (e.g., 72-hour submission window). This assessment flexibility must be indicated on the course outline.

V. Religious Accommodation

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student

will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.
It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

VI. Academic Integrity

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect, responsibility, and courage, befitting the professional degree you are pursuing.
Please visit Academic Integrity Western Engineering for more information

VII. Academic Offences

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.
Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know
Students must write their reports, essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations.
University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.
All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VIII. Faculty of Engineering AI Policy

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.

GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

IX. Use of English Policy

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

X. Accessibility

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the Accessibility Western University for information on accessibility-related resources available at Western.
Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit Academic Support & Engagement -Academic Accommodation.

XI. Inclusivity, Diversity, and Respect

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the Office of Equity, Diversity and Inclusion.

XII. Health and Well-Being

- Health & Wellness Services – Students - Offers appointment-based medical clinic for all registered part-time and full-time students.
- Mental Health Support - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- Crisis Support - For immediate assistant, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click here.
- Gender-Based Violence and Survivor Support - Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, here. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Chemical and Biochemical Engineering	TEB 477	519-661-2111 (x82131)	brandy.hunter@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links

- WESTERN ACADEMIC CALENDAR
- ACADEMIC RIGHTS AND RESPONSIBILITIES
- ENGINEERING PROGRESSION REQUIREMENTS AND ACADEMIC REGULATIONS
- UNIVERSITY STUDENTS' COUNCIL (USC) - SERVICES
- IMPORTANT DATES AND DEADLINES
- ACADEMIC CONSIDERATION FOR MEDICAL ILLNESS - UNDERGRADUATE STUDENTS
- ACCOMMODATIONS FOR RELIGIOUS HOLIDAYS

- SCHEDULING OF ASSIGNMENTS, TESTS, AND EXAMINATIONS
- STUDENT FORMS
- OFFICE OF THE REGISTRAR
- RETENTION OF ELECTRONIC VERSION OF COURSE OUTLINES (SYLLABI)
- ACADEMIC APPEALS
- STUDENT ABSENCE PORTAL