CHEG 4995: Energy and Fuels
Fall 2017

Instructor: Ioulia (Julia) Valla, email: ioulia.valla@uconn.edu

Time & Location of classes: Lecture Sections: TT - 11:00 – 12:45 - EII 323

Textbook: No single textbook. Multiple textbooks, scientific papers and websites will be used

Course Notifications: Most class correspondence will occur via HUSKYCT (http://huskyct.uconn.edu)

Time and Location of Prof Valla's Office Hours: By request

Teaching Assistant: Not assigned yet.

Student Outcomes
At the end of this course the students will be able to:

1) Demonstrate knowledge of the concepts and principles of energy and fuel resources, production and processing by applying energy and mass balances (ABET a, e, f)
2) Demonstrate knowledge of the fundamentals of fuels processing in refinery and biorefinery processes and industrial (catalytic and non catalytic) processes by constructing and analyzing systems level flow diagrams (ABET a, e, f, j)
3) Develop, solve and analyze chemical engineering systems and processes by applying fundamental concepts of thermodynamics and reaction kinetics as well as fundamental concepts from physics, biology, chemistry and mathematics (ABET a, e f)
4) Demonstrate an ability to work in teams and to communicate effectively, via interim and final progress reports, written and oral (ABET g, j)
5) Analyze, propose solutions and present modern challenges in Chemical Engineering Processes which involve Fuel Processing (ABET a, e, f, g, j)

ABET Objectives
In this course, student progress towards the following ABET Engineering Objectives will be assessed:
(a) An ability to apply knowledge of math, science and engineering in the general field of chemical engineering
(e) An ability to identify, formulate and solve chemical engineering problems
(f) An understanding of professional and ethical responsibility; this includes protecting the public and the environment by performing their work in a safe and environmentally conscious manner
(g) An ability to communicate effectively
(j) A knowledge of contemporary issues

Performance Table

	Outstanding **>90**	**Minimum Acceptable** **70**	**Unacceptable** **<50**	
1) Demonstrate knowledge of the concepts and principles of energy and fuel resources, production and processing by applying energy and mass balances (ABET a, e, f)				
	Almost no errors in the systems of energy and fuel production and processing as well as in energy and mass balances	Correct formulation of the problem/system/equations, though students may arrive at an incorrect solution or neglected necessary information	Significant errors is problem formulation and or incorrect solution approach and neglect critical process step mistakes	
2) Demonstrate knowledge of the fundamentals of fuels processing in refinery and biorefinery processes and industrial (catalytic and non catalytic) processes by constructing and analyzing systems level flow diagrams (ABET a, e, f, j)				
	Students are able to identify, construct and analyze the systems flow diagram, connect unit operations and solve independent equations for unit operations.	Students are able to identify the correct unit operations but they are not able to construct and analyze a correct flow diagrams	Students were not able to identify the correct approach to flow diagrams. Do not understand the symbolism to read flow diagrams and or cannot set up systems of equations to solve problems .Results are incorrect and discussion focuses on generalities.	
3) Develop, solve and analyze chemical engineering systems and processes by applying fundamental concepts of thermodynamics and reaction kinetics as well as fundamental concepts from physics, biology, chemistry and mathematics (ABET a, e f)				
	Almost no errors in system conception or applying correct equations	Correct formulation of the problem, though students may arrive in an incorrect solution or neglect necessary information	Significant errors is problem formulation and or incorrect solution approach and neglect critical process step incorrectiomn	
4) Demonstrate an ability to work in teams and to communicate effectively, via interim and final progress reports, written and oral. (*ABET d, g*)				
	Team work is equally weighted between team members. Presentations and reports identify contributions from all members and acknowledgment to the task lead. Reports are written clearly and are focused. Project outcomes and the interaction between team members are sufficiently discussed.	Team work is equally weighted between team members, but acknowledgment to task leads is missing. Reports lack focus and discuss generalities. Project outcomes are correct but interaction between task leads is missing	Team work is not equally weighted between members. Presentations are diluted with generalities and missing important information and outcomes. Interaction between task leads is not sufficient. Presentations and reports lack clarity. Outcomes are not discussed.	
5) Analyze, propose solutions and present modern challenges in Chemical Engineering Processes which involve Fuel Processing (ABET a, e, f, g, j)				
	Students performed a basic literature review of the challenge identified. If asked they have identified an	Literature review of the challenge identified was insufficient. They have not identified an intriguing	Literature review of the challenge identified is missing. They have not identified an intriguing problem and	

	intriguing problem of global significance and explained the potential consequences of the solution proposed. Approach to addressing this problem is correct and might entail novel components. Assumptions are correct and discussed sufficiently.	problem and the significance of the problem is not justified. Approach to addressing this problem is correct but does not entail novel components. Project solution is too simple and missing important components. Assumptions are correct but not discussed sufficiently.	the significance of the problem is not justified. Approach to addressing this problem is not correct. Project solution is too simple or similar to existing solutions and missing important components. Assumptions are incorrect or not discussed sufficiently.	

Grading

During the semester, students will be challenged in ***four assignments/projects*** during the semester. Each assignment will contribute with 25% of the total grade. No final exams will take place.
The four assignments will be integrated with the Service Learning Program. Specifically, the students will visit the Spring Valley Farm to understand how the Farm operates and what the goals of the people working there are. Each one of the four assignments/projects (which are described in the Tentative Schedule Section) will be tied with the needs of the Farm. For example the Assignment #1 is about Refinery and Biorefinery. In a Biorefinery the goal is to utilize biomass to create fuels and energy. The students will generate this knowledge from the lectures. During the assignment they will be requested to use their knowledge on biomass utilization to design a process, where waste biomass derived from the Farm could be used to generate energy and fuels.

Assignments

The four assignments will involve an in-class presentation and a report. The assignments will require team-work (4 students per group/team). The groups will be presenting their work on Tuesdays and they will provide their reports on Thursday of the designated weeks. Rubric will be provided.

Other Policies

Student Conduct: http://www.dosa.uconn.edu/student_code.html. Students are responsible for adherence to the University of Connecticut student code of conduct. Perhaps the most important policy to pay attention to is the section on Student Academic Misconduct. “Academic misconduct is dishonest or unethical academic behavior that includes, but is not limited, to misrepresenting mastery in an academic area (e.g., cheating), intentionally or knowingly failing to properly credit information, research or ideas to their rightful originators or representing such information, research or ideas as your own (e.g., plagiarism).” Examples of academic misconduct in this class include, but are not limited to: copying solutions from the solutions manual, using solutions from students who have taken this course in previous years, copying your friends’ homework, looking at another student’s paper during an exam, lying to the professor or TA and incorrectly filling out the student workbook.

Attendance: Attendance and participation is mandatory and will be graded via in-class quizzes and multi-choice questions.

Absences: Make-up of ANY missed exams requires permission from the Dean of Students; see "Academic Regulations." Midterm-exams are treated the same as Final Examinations. Students involved in official University activities that conflict with class time must inform the instructor in writing prior to the anticipated absence and take the initiative to make up missed work in a timely fashion. In addition, students who will miss class for a religious observance must "inform their instructor in writing within the first three weeks of the semester, and prior to the anticipated absence, and should take the initiative to work out with the instructor a schedule for making up missed work."

Tentative Sections/Schedule

Syllabus

Section 1: Introduction

Our Hunger for Energy and Fuels

I. Discussion
- Energy: Who needs what, where and how much
- Carbon Free Energy: Vision or Utopia
- The Climate before the collapse

II. Fossil & Renewable Energy and Fuels
- Oil – The Black Gold
- Natural gas – The Newest Fossil Fuel
- Coal – The Dirty Fuel

III. Renewable Energy and Fuels
- Biomass – Energy from Nature
- Hydropower – Wet Energy
- Geothermal – Energy from the Deep
- Solar – Sunny Prospects
- Wind – Electricity from the air

IV. The Nuclear Energy – Split Energy

Section 2: Refinery and Bio-refinery

Petrochemicals and Refinery

I. **Hydrocarbon (Oil) Processes to Energy, Fuels and Chemicals –The Refinery**
- Fluid Catalytic Cracking
- Hydrocracking & Hydrotreating
- Reforming
- Isomerization & Alkylation

II. **The first oil crisis and the price of oil**

III. **Environmental issues of oil**

IV. **Outlook and Recommendations**

Renewable resources and biomass

I. **Renewable Resources and Fuels**
- Biomass
- Geothermal
- Solar & Wind

II. **Biomass processes**
- Pyrolysis
- Gasification
- Chemical Routes

Biorefinery

I. **Bio-refinery**
- Biomass Heat and Power Plants
- Biofuels (Bio-oil, Bio-diesel, Bioethanol, BtL, Biogas)
- Economics and Future of Biomass as a Resource
- The case of Biofuels in Brazil

II. **Visit at the Spring Valley Farm**

III. **Assignment #1: Refinery vs Bio-refinery**

Update the Annex and Non Annex countries of the Kyoto Protocol

Integrate the concept of bio-refinery in the Spring Valley Farm.

Section 3: Hydrogen Economy

Hydrogen as a Fuel

I. Hydrogen as a fuel
- Hydrogen Economy
- Production of Hydrogen
- Separation Storage and transport of Hydrogen

Hydrogen resources and usage

I. Natural Gas: The most efficient Hydrogen Source
II. Fuel Cells: Bearers of Hope
III. Market, Outlook and Development
IV. Potential of Hydrogen as Fuel

Assignment #2: The future of Hydrogen Economy.

Present a new technology for the production /storage/separation /application of hydrogen.

Can we produce and utilize hydrogen in the Spring Valley Farm? What would be the most sustainable and economic way to do that through their waste.

Section 4: Industrial Catalytic Processes

The roles of catalysis

I. The role of catalysis in the Fuel Processing and Energy Production
II. Zeolites and FCC catalysts
- Properties and Structure
- Deactivation
- Applications in refinery and Bio-refinery

Catalysts types

I. Zeolites and separation
II. Reforming catalysts
III. Metal oxides
IV. Metal Organic Framework

Assignment #3: Green catalysts

Scientists discover or design green catalysts to accelerate chemical reactions, manufacture cheaper or cleaner products etc. Present an example of novel, green catalyst to improve the efficiency or lower the cost of a challenging catalytic process. If a catalyst needs to be used for a process designed for the Spring Valley Farm, what is the most appropriate one?

Section 5: Your role in the Future of Energy and Fuels Production

I. Energy Economics and Management
   - Costs and Benefits
   - Sustainable development
   - Energy and Ethics
   - Global Regulations of Carbon Emissions
   - Renewable Energy Forecast
   - The Future of Energy

Assignment #4: How do you solve the energy/climate crisis? Your dream job.

Assuming that as a chemicals engineer you will find a job in the energy sector: what is the energy/fuel resource and process you would like to work with, in order to solve the climate crisis? Integrate your ideas and thoughts with the Service Learning Experience.