CENG S105E (Su21): Introduction to Green Energy Systems (GES)

Course Syllabus, Summer 2021

Course Instructor: Dr. Yehia Khalil

- *Member of Connecticut Academy of Science & Engineering (CASE)*
- *Recipient of the Senior Moulton Medal from the United Kingdom's Institution of Chemical Engineering (IChemE) for excellent fundamental research in the chemical field.*
- *Elected Technical Fellow at the University of Oxford, United Kingdom.*
- *Chairman of the Hydrogen Technologies R&D Programs of the International Energy Agency (IEA), Paris, France.*
- *Past Yale faculty advisor of the Students Chapter of the American Institute of Chemical Engineers (AIChE) and a faculty advisor of Yale Community Based Learning (CBL).*
- *Editor-in-Chief, Hydrogen Safety Journal, the International Energy Agency (IEA), Paris, France.*

Yehia Khalil, Ph.D., Sc.D.

Primary e-mail:
Yehia.khalil@yale.edu
Alternate e-mails:
Khalil@alum.MIT.edu
ykhalil@alumni.Stanford.edu
ykhalil@alumni.Harvard.edu
Yehia.khalil@hmc.ox.ac.uk
ykhalil@ieahydrogen.org

Address:
Yale School of Engineering & Applied Science
Office: ML-204, 9 Hillhouse Ave.
New Haven, CT 6520

Course prerequisite: Instructor's permission.

Scope:

The course topics covers renewable (green) energy systems including concentrated sola power (CSP), solar photovoltaics (solar PV), wind, biofuels, hydropower, geothermal, nuclear power, ocean thermal energy conversion (OTEC), tidal and wave power harvesting. The topics also cover life cycle impact of assessment (LCIA) of renewable energy sources, energy storage technologies to offset intermittency of solar and wind energy sources, role of the smart-grids and distributed energy generation in reducing CO_2 emissions from the electricity generation sector, main CO_2 capture technologies (both pre-combustion and post combustion), carbon capture and storage (CCS), role of the hydrogen economy in reducing greenhouse gas emissions from the transportation sector, benefits & safety concerns associated with injecting hydrogen in the natural gas pipelines for domestic heating as well as harvesting and converting waste energy into electricity using smart materials.

Main textbook:

Godfrey Boyle (Editor), Renewable Energy: Power for Sustainable Future, Second Edition, Oxford University Press, UK, ISBN# 0-19-926178-4, 2004.

Lecture Topics:

1. Introduction to renewable energy sources, primary criteria for sustainable energy technologies, and life cycle impact assessment (LCIA) using the state-of-art computational tools such as *SustainableMinds*, *OpenLCA*, and GaBi platforms.
2. Corporate sustainability and social responsibility.
3. Corporate carbon footprint counting (scope 1, scope 2, and scope 3 emissions) with case studies.
4. Hydrogen applications including its injection into the natural gas pipelines for domestic heating.
5. Wind Power.
6. Concentrated solar power (CSP).
7. Solar Photovoltaic.
8. Bioenergy.
9. Hydropower.
8. Tidal Power.
9. Wave Energy.
10. Geothermal Energy.
11. Energy Storage.
12. Nuclear Power.
13. Tidal and wave energy harvesting.
14. Carbon capture technologies (pre-combustion and post-combustion).
15. Carbon capture and storage (CCS).
16. Fuel cell technologies and smart materials for harvesting and conversion of waste energy into electricity.

Grade Distribution:

Homework = 15 points, participation in class discussions = 15 points, mid-term exam = 20 points, team-based project = 30 points and final exam = 20 points.

Active class participation:

Active class participation is expected in this course. Accordingly, during the first 45 minutes in each class the course instructor will review the key points and takeaways from the assigned lecture notes & recorded video lectures, and will answer questions that the students may have based on their readings of the course materials. During the second 45 minutes of each class, students will discuss their own perspectives and insights gained from the assigned homework. During lecture 1 of Week 1, the course instructor will provide additional clarification on the mechanics of required active participation expected of the students.

Nature and Purpose of the Course:

Enhance the students' understanding of environmental sustainability, corporate social responsibility, and the role of renewable (green) energy technologies in mitigating impact of greenhouse gases and the resulting global warming. The students will be assigned reading materials on environmental sustainability and will learn how to calculate the system-level performance, overall efficiency, cost, and environmental impact assessment of integrated renewable (green) energy systems.