JEE 659 Energy from biomass

(Course coordinator: Assoc.Prof.Dr. Nakorn Worasuwannarak)

1. Course Description

This course aims to give students an understanding of the processes to produce the energy from biomass. The advantages of bio-energy production and various technologies for biomass conversion for heat and power are reviewed. The thermochemical conversion of biomass includes combustion, gasification, and pyrolysis. Biogas, biofuel and bio-refinery are also included. Finally, the economic assessment of biomass utilization system, the impact on environmental and the policy framework for biomass utilization will be discussed.

2. Target Knowledge, Skills, and Abilities (KSA)

Indicate what KSA this course will provide the students with.

This course provides students with knowledge of biomass conversion technologies for energy production and their impact on environment. The skills to analyze the bio-energy systems from various types of biomasses in the critical thinking manner will be provided.

3. Target group of students

Indicate if the course is opened for all students, including non-degree ones.

This course is opened to Master and PhD students with a background in science or engineering.

4. Pre-requisites

Indicate if the course requires some pre-requisites.

No pre-requisites are required.

5. Course Learning Outcomes

Indicate the alignment of CLOs with the PLOs.

CLO 1: Able to define the concept of sustainable development.

CLO 2: Able to explain the challenges and potentials for development of various energy technologies.

CLO 3: Able to analyze the environmental impacts of conventional and alternative energy technologies.

6. Method of Teaching and Learning

Specify if it would be 1/ Online; 2/ On-site; 3/ Hybrid; 4/ Online for lectures and On-site in small groups for discussions and workshops; 5/ Others.

This course will be delivered in a hybrid format, i.e. a combination of online and on-site lectures and presentations.

7. Course Outline and Organization

Following KMUTT's recommendations, a course should be organized based on the OBEM approach. A course can, therefore, be split over the semester, but also organized in consecutive weeks as before. A module can contain from 2 up to a maximum of 5 lectures depending on the target LOs. A 3 credits course

can be composed of 3 to a maximum of 5 modules. In addition, indicate if ***the course is opened every Semester or a specific Semester***.

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This course is opened every Semester. For the Semester 1/2022 (2565), this course is scheduled every Thursday afternoon (1.30 p.m. – 4.30 p.m.) from Thursday 11 August to 8 December 2022.

MODULE 1: BIOMASS POTENTIAL ASSESSMENT, BIOMASS CHARACTERIZATION, BASIC COMBUSTION CALCULATION **MLO 1:** Understand the important of biomass and bio-energy system. **MLO 2:** Gain knowledge on how to assess the potential of biomass. **MLO 3:** Understand the fuel characteristics of various types of biomasses. **MLO 4:** Understand the basic calculation of biomass combustion.		
Lecture No.: Title	Name of Instructor (Affiliation)	Teaching Period
LECTURE 1: Overview of biomass and bio-energy	Dr. Nakorn Worasuwannarak	Week 1
LECTURE 2: Biomass potential assessment	Dr. Nakorn Worasuwannarak	Week 2
LECTURE 3: Biomass fuel characterization	Dr. Nakorn Worasuwannarak	Week 3
LECTURE 4: Basic calculation of biomass combustion	Dr. Nakorn Worasuwannarak	Week 4
EVALUATION: Essay questions and take-home work		

MODULE 2: THERMOCHEMICAL CONVERSION OF BIOMASS **MLO 1:** Gain knowledge on biomass pretreatment **MLO 2:** Gain knowledge on biomass combustion technologies **MLO 3:** Gain knowledge on pyrolysis & bio-oil production **MLO 4:** Gain knowledge on biomass gasification		
Lecture No.: Title	Name of Instructor (Affiliation)	Teaching Period
LECTURE 1: Biomass pretreatment	Dr. Nakorn Worasuwannarak	Week 5
LECTURE 2: Biomass combustion technologies & CHP application	Dr. Nakorn Worasuwannarak	Week 6
LECTURE 3: Pyrolysis & bio-oil production	Dr. Nakorn Worasuwannarak	Week 7
LECTURE 4: Biomass gasification & other advanced uses	Dr. Nakorn Worasuwannarak	Week 8
EVALUATION: Essay questions and take-home work		

MODULE 3: BIOFUELS, BIOGAS, AND OTHER ADVANCED BIOMASS TO LIQUID **MLO 1:** Gain knowledge on bio-ethanol productioin **MLO 2:** Gain knowledge on bio-diesel production **MLO 3:** Gain knowledge on biogas production **MLO 4:** Gain knowledge on other advanced biomass to liquid		
Lecture No.: Title	Name of Instructor (Affiliation)	Teaching Period
LECTURE 1: Bio-ethanol	Dr. Boonrod Sajjakulnukij	Week 9
LECTURE 2: Bio-diesel	Dr. Boonrod Sajjakulnukij	Week 10
LECTURE 3: Biogas production and utilization	Dr. Warinthorn Songkasiri	Week 11
LECTURE 4: Other advanced biomass to liquid	Dr. Nakorn Worasuwannarak	Week 12
EVALUATION: Essay questions and take-home work		

MODULE 4: ECONOMIC ASSESSMENT, POLICY FRAMEWORK, AND ENVIRONMENTAL ASSESSMENT **MLO 1:** Understand how to assess the economic of biomass utilization system **MLO 2:** Understand the policy framework for biomass utilization **MLO 3:** Can assess the environment and sustainability of biomass utilization system		
Lecture No.: Title	Name of Instructor (Affiliation)	Teaching Period
LECTURE 1: Economic assessment of biomass utilization system	Dr. Boonrod Sajjakulnukij	Week 13
LECTURE 2: Policy framework for biomass utilization	Dr. Boonrod Sajjakulnukij	Week 14
LECTURE 3: Environment and sustainability assessment of biomass utilization system	Prof. Shabbir Gheewala	Week 15
EVALUATION: Essay questions and take-home work		

Note: *You may modify this template (number of modules, lectures and MLOs) as appropriate for your course.*

8. Evaluation Methods

Indicate the methods used to evaluate the LOs, e.g. online or on-site exams, assignments, take-home exams, projects, etc. Following KMUTT's recommendations, the LOs evaluation should be organized at the end of each module.

Module 1: The exam consists of essay questions and take-home work (25% overall grade for the course)

Module 2: The exam consists of essay questions and take-home work (25% overall grade for the course)

Module 3: The exam consists of essay questions and take-home work (25% overall grade for the course)

Module 4: The exam consists of essay questions and take-home work (25% overall grade for the course)

9. References/Resources

Indicate the references/resources students are recommended to consult for the modules/course.

1. Sims, R. (2002) *The Brilliance of Bioenergy in Business and Practice*, Routledge
2. Bhatt, B. (2010) Stoichiometry, Fifth edition, Tata McGraw Hill Education Private Limited
3. Capareda, S. (2013) *Introduction to Biomass Energy Conversions*, CRC Press
4. Szubel, M. (2019) *Biomass in Small-Scale Energy Applications: Theory and Practice*, CRC Press
5. Castro, F.I.G., et al. (2022) *Biofuels and Biorefining: Volume 1: Current Technologies for Biomass Conversion*, Elsevier