Biomass and biofuels in energy production

Faculty of	**Mechanical and Power Engineering**
Name in English	**Biomass and biofuels in energy production**
Name in Polish	**Produkcja energii z biomasy i biopaliw**
Main field of study	**Power Engineering**
Specialization	**-**
Level of studies	**II level**
Form of studies	**full-time**
Kind of subject	**optional-specialization**
Subject code	**W09ENG-SM2351**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15	15	
Number of hours of total student workload (CNPS)	50		25	25	
Form of crediting	Egzamin		Zaliczenie	Zaliczenie	
For group of courses mark final course with (X)					
Number of ECTS points	2		1	1	
including number of ECTS points for practical (P) classes			1	1	
including number of ECTS points for direct teacher-student contact (BU) classes	1,44		0,76	0,76	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	Thermodynamics, combustion and boilers, heat transfer
2.	Environmental protection issues, waste management

SUBJECT OBJECTIVES

C1	Introduction to classification and general characteristics of biomass and biowaste as fuel acquainted with the processes of biomass preparation for energy production. Familiarization with the technologies of energy production from biomass and biofuels.
C2	Development skills of characterizing biofuels for the power energy sector.
C3	Acquisition of skills for biomass boiler balance calculation and evaluation of biomass furnaces.

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
PEU_W01	Describe the general classification of biomass and characterize their fundamental properties and analytical methods for their determination
PEU_W02	Description of the mechanisms of combustion of biomass and list the main systems of combustion and pretreatment of biomass and biowaste
PEU_W03	Identify and characterize the main technologies of biomass co-firing with conventional solid fuels

relating to skills:	
PEU_U01	Identify and characterize the main parameters and processes characterizing biofuels for the power energy sector.
PEU_U02	Perform balance calculations of biomass boiler, with combustion chamber, – depends on type of biomass.

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Wy1-3	State of art for energy production from biomass. The potential of biomass, biomass types, definition of basic physical-chemical properties of biomass; power plant technical limitations resulting from biomass properties. Analytical methods of biomass characterization as a fuel.	6
Wy4-6	Energy fuel production from biomass formed by the mechanical and thermal pretreatment: drying, pelletizing, grinding, torrefaction and pyrolysis, fermentation,	6
Wy7-9	Combustion of biomass. Small, medium and large capacity power units using biomass. Types of furnaces depending on the boiler capacity, co-firing technique - advantages and disadvantages in power boilers. Transport system of biomass and its storage.	6
Wy10-14	The current state of the environment and reasons for searching for new energy sources. Causes and sources of waste generation in technological processes. Polish and EU policy on waste management. Legal, environmental and technological aspects of the use of alternative fuels, solid and liquid bio-waste. Preparation, processing and management of alternative fuels. Circular economy.	10
Wy15	Colloquium.	2
Suma godzin		

laboratory		Number of hours
La1-5	Characterization of alternative fuels, preparation for testing, sample averaging, grinding. Determining the content of chlorine, mercury and calorific value, classifying fuels in accordance with CEN standards, and determining the share of the biogenic part.	9
La6-8	Analysis of thermal and pretreatment of biomass and utilization under combustion processes: drying , torrefaction, combustion with the flue gas analysis.	6
Suma godzin		15

project		Number of hours
Pr1-2	Calculation of different type biomass composition with LHV for different moisture content	3
Pr3-4	Balance calculation of biomass combustion in stoichiometric condition.	4
Pr5-6	Thermal balance calculation of selected biomass furnace, calculation of combustion efficiency.	4
Pr7-8	Design of combustion chamber fired with biomass.	4
Suma godzin		15

TEACHING TOOLS USED	
N1	Traditional lecture using multimedia presentation
N2	Individual work - self-study and exam preparation
N3	Discussion of laboratory tasks, individual work - preparation for laboratory
N4	Conceptual design and discussion of solutions for calculations.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation	Educational effect number	Way of evaluating educational effect achievement

(F– forming (during semester), C– concluding (at semester end)		
C1	PEU_W01-W03	Colloquium.
F1	PEU_U01	Evaluation of reports. P=(F1+F2+...+Fn)/n
C2	PEU_U02	Evaluation of final project and discussion in the field of biomass technology.

PRIMARY AND SECONDARY LITERATURE

Primary literature	
1	Rosendahl L., Biomass combustion science, technology and engineering, Woodhead Publishing Limited, 2013
2	Dahlquist E., Technologies for converting biomass to useful energy: combustion, gasification, pyrolysis, torrefaction and fermentation, CRC Press, Taylor & Francis Group, 2013,
3	Jaap K. Van Loo S., The handbook of Biomass Combustion and Co-firing; Earthscan Publications, Taylor & Francis Ltd., 2008
4	Tillman D. A., Wood Combustion, Elsevier, 2012
5	Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies, P. Jayarama Reddy, 2016
6	Waste Incineration Handbook, Paul N. Cheremisinoff, 2013
7	Alternative Fuels and Advanced Combustion Techniques as Sustainable Solutions for Internal Combustion Engines, Dhananjay Kumar, Avinash Kumar Agarwal, 2016
8	Basu P, .Boilers and Burners Design and Theory, Springer New York, 2012
Secondary literature	
1	GE. Klugmann-Radziemska; J. T. Haponiuk; J. G. Datta; K. Formela; M. Sienkiewicz; M. Włoch, Nowoczesne technologie recyklingu materiałowego, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2017.
2	International Energy Agency, https://www.iea.org
3	Bank Danych Lokalnych, https://www.bdl.stat.gov.pl
4	Internetowy System Aktów Prawnych (ISAP), http://prawo.sejm.gov.pl
5	EUR-Lex Baza aktów prawnych Unii Europejskiej, https://eur-lex.europa.eu
6	Confederation of European Waste-to-Energy Plants, http://www.cewep.eu
7	M. Hordyńska, Ekologistyka i zagospodarowanie odpadów, Wydawnictwo Politechniki Śląskiej, Gliwice 2017
8	Kruczek S., Kotły. Konstrukcje i obliczenia, Oficyna Wydawnicza Politechniki Wrocławskiej, 2002
9	R. Wasielewski, B. Tora, Stałe paliwa wtórne, Górnictwo i Geoinżynieria, Rok 33, Zeszyt 4, 2009

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Imię i nazwisko:	supervisor: PhD Michał Ostrycharczyk teaching team: PhD Arkadiusz Szydełko, PhD Krystian Krochmalny
E-mail:	michal.ostrycharczyk@pwr.edu.pl