(pieczęć jednostki organizacyjnej)

SUBJECT CARD

1) Name of the subject: MATHEMATICAL MODELLING OF ENERGY INSTALLATIONS	**2) Course code:**
3) Valid in academic year: 2019/2020	
4) Course: MSc (second degree programme)	
5) Type of studies: full time stationery course	
6) Field of study: POWER ENGINEERING	
7) Profile of studies: General academic	
8) Programme: CLEAN FOSSIL AND ALTERNATIVE FUELS ENERGY (KIC INNOENERGY)	
9) Semester: 2	
10) Responsible unit: Department of Thermal Engineering (RiE-6)	
11) Lecturer: dr hab. inż. Marcin Szega, prof. of the SUT	
12) Group of subjects: Major subject	
13) Status: Obligatory	
14) Language of instruction: English	
15) Learning outcomes: mathematics, thermodynamics, heat transfer, energy management	
16) Objective of the course: The aim of the course is to introduce students to contemporary computer aided methods and software for modelling and simulating energy systems and installations. The course consists of lectures and hands-on training in computer laboratory.	

17) Learning outcomes:[1]

Nr	Description of learning outcome	Method of assessments	Type of classes	Reference to learning outcomes
1	Student is able to characterize properties of fuels, working fluids and materials used in energy processes	Written test, oral answer	Lectures	K_W12
2	Student is able to select fuel and working fluid for a given energy conversion process	Written test, oral answer	Lectures	K_U17
3	Student is able to build mathematical model of a given energy installation and energy characteristics	Written test, oral answer	Lectures, Laboratory	K_U18, K_U19
4	Student is able to use commercial software for design and analysis of energy processes	Written test, Elaborated project	Laboratory	K_U20, K_U23
5	Student is able to propose machinery and devices for a given energy conversion process	Written test, elaborated project, oral answer	Lectures, Laboratory	K_U24

18) Type of classes and their duration

Lectures	Recitations	Lab	Project	Seminar
15 h	**-**	**45 h**	**-**	**-**

Content of the course:

Before the stage of construction of any energy system (power plant, heat-and- power plant, heating plant) every project has to be proceeded by numerous technical and economical studies. These studies should identify possible technological and constructional solutions and optimal operation parameters for given load and ambient conditions.

[1] 5-8 learning outcomes should be given

The initial stage of so called "pre-feasibility" studies should generate the optimal investment strategy for the project realization.

The lecture consists of the following subjects: characteristics of computer packages for modelling of thermal systems, defining and solving modelling problems, process flow sheeting and balancing, characteristics of main components of thermal plants, transformation of real objects into the model environment - making assumptions, design and off-design modes of computer simulations, introduction to optimization, introduction to the computer packages used in hands-on training, examples of how to model plants. Issues of direct energy consumption, cumulative energy consumption, energy characteristics, balance method of thermal process modelling, "input-output" mathematical modelling of large energy system in an industry and data validation and reconciliation in thermal engineering also are presented.

Within hands-on training the students build and solve problems in the field of energy plant design using the following software: Engineering Equation Solver from F-Chart software, Ebsilon Professional from Steag Energy Services and CoolProp software. They are instructed how to build and run the models. The examples of problems are as follows: modelling of coal fired cogeneration plant, modelling of gas turbine plant, gas power unit, combining gas turbine and coal fired units into single combined cycle dual-fuel installation.

Lectures are conducted in an interactive way with use of audiovisual tools. During the lecture problem questions/topics are raised, students take part in the discussion and brainstorms, trying to find solution/answers, assess existing solutions as well as develop critical thinking. Students are encouraged to participate in discussions which are moderated by the tutor. Students will be assess to assess the dynamic nature of complex systems and change over time. They will be able to apply the tools and concepts of system dynamics and systems thinking in their present lives.

19) Examination: No

20) Basic literature:

1. Cengel Y., Boles M.A.: Thermodynamics - An Engineering Approach. ISBN 978-007-131111-3,
2. Cengel Y.A., Ghajar A.J. Heat and Mass Transfer - Fundamentals and Applications. ISBN 978-007-131112-0;
3. Bejan A., Tsatsaronis G., Moran M.: *Thermal design and optimisation*. A Wiley- Interscience Publication, John Wiley and Sons, INC. New York 1996.;
4. Journal papers: Energy, Energy Conversions and Management. Proceedings of annual ECOS Conference.

21) Other reading: Scientific journals availabale in university network (Scopus, Science direct etc.)

22) Work load of the student necessary to achieve the learning outcomes

Lp.	Type of classes	Number of contact hours / student work
1	Lectures	15/30
2	Recitations	/
3	Lab	45/30
4	Project	/
5	Seminar	
6	Other (participation in consultations associated with project execution)	/
	Number of hours (subtotal)	60/60

23. Total number of hours: 120

24. Number of ECTS credits: 4

25. Number of ECTS credit points gained during classes (contact hours): 2

26. Number of ECTS credits gained during practice oriented classes (labs, projects): 2

27. Remarks:

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(data i podpis prowadzącego) (*data i podpis Dyrektora/Kierownika podstawowej*

lub międzywydziałowej jednostki organizacyjnej)

[1] 1 ECTS point – 30 hours workload