GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Solar energy conversion, PG_00035164		
Field of study	Technical Physics		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2023/2024
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	1	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division Of Molecular Photophysics -> Institute Of Physics And Applied Computer Science -> Faculty Of Applied Physics And Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	Katarzyna Siuzdak	
	Teachers	Katarzyna Grochowska Katarzyna Siuzdak	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	0.0	15.0	45

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	45	6.0	24.0	75

Subject objectives

The extension of the students' knowledge about the methods of converting solar energy into other forms of useful energy. Presentation of the theoretical basis of the photovoltaic-, photochemical- and photothermal conversion and current practical solutions using these methods

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U06] Can apply obtained knowledge of physics to exact sciences, natural and technical sciences.	The student can apply his knowledge of physics to problems from the other natural sciences or engineering.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_U01] Can learn independently, obtain and integrate information from literature, databases and other properly selected sources (in Polish and English). Can critically analyze and select information. Can use patent information resources.	The student can independently acquire and use relevant information from different sources	[SU2] Assessment of ability to analyse information
[K7_W02] Has enhanced, theoretically-founded, detailed knowledge of selected field of physics, and sufficient knowledge of related fields of science or technology.	The student has the relevant theoretical knowledge and specific experience in the conversion of radiant energy into other forms of energy and on the related fields of science and technology	[SW1] Assessment of factual knowledge

Subject contents	Lecture: - Sun and its structure, quantitative description, sundials, history of Sun research - black body, solar radiation outside the Earth's atmosphere, atmospheric influence, Mie and Rayleigh scattering, AM0, AM 1.5 - solar time, hourly angles, determination of sunrise and sunset hour, declination, equation of time, angular height, azimuth - angle of incidence of sunlight, irradiation, solar radiation, total, daily, hourly solar radiation energy, radiation components on the Earth's surface, pyrometer, albedo - monthly, daily and hourly average sky clearness index, correlation equations, total solar radiation on a forward-tilted plane - photothermal conversion; solar collectors, types and properties, flat collectors, non-concentrating liquid, flat liquid collector, absorbers for collectors, energy conservation in the absorber, radiation absorbed by the collector; selective coverings of solar collector absorbers, transparent covers, anti-reflection coverings, thermal insulation materials, working fluids with a low freezing point, penetration of solar radiation through transparent collector covers - collector efficiency in the steady state, incidence angle modifier, optimal inclination angle, collector systems, mutual shading, useful thermal power, heat transfer coefficient, heat losses, thermosyphon installation - vacuum tube collector - comparison, sample installation at different latitudes, concentric systems, concentration factor, temperature, follow-up systems - helioenergy technologies in Poland - semiconductors and the photovoltaic effect, p-n junction, PV cell characteristics, electrical parameters, their measurement and calculation, solar simulators - silicon cells: mono and polycrystalline, amorphous, micro and nanocrystalline, CIGS, methods of increasing cell efficiency - dye sentisitized solar cells: structure and principle of operation, organic and polymer solar cells, perovskite solar cells - degradation of cells over time and under the influence of light, recycling and environmental impact - use of radiation to generate hydrogen: photochemical conversion, theoretical foundations (water decomposition), electrolyte, 3-electrode system, methods of using solar radiation to obtain hydrogen, hydrogen purification - the latest achievements in the use of solar energy, current status and development prospects of photovoltaic energy Seminar: - How to calculate the height of the Sun? - Artificial Sun project. What is it, how can it help us and can it be built?

- Can satellites be a source of energy?

- Solar cells in space

- Can a solar power plant be built in space?

- Solar farms - the advisability of their use in various places around the world

- Are home photovoltaic installations profitable and how to choose them?

- Impact of photovoltaics on the environment

- Solar energy storage off-grid installation (batteries, mechanical storage, chemical energy storage, supercapacitors, thermal storage)

- Off-grid or on-grid installations? Advantages and disadvantages of the procedure for connecting to the network

- Why are perovskite cells not yet commercially available?

- Is it worth developing transparent solar cells?

- Purification of drinking water using solar energy and related problems

- Photovoltaic phenomenon in biological systems (BPV biological photovoltaics). Should we be inspired by anything?

- Other examples of the use of solar energy (everyday use devices, phones, chargers, bags). Do such solutions make sense?

- Solar collector systems

- Trombe air collector

- Passive heating systems, was the hobbit house energy passive?

- Hydrogen economy in Poland, current state and prospects

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
seminar: oral	100.0%	40.0%
lecture : test	51.0%	60.0%

Recommended reading

Basic literature	1. S. Kalogirou, Solar energy engineering: process and systems, Elsevier 2009 2. D. Halliday, R. Resnick, J. Walker, Fundamentals of physics, PWN 2015 3. A. A. Ojo, W. M. Cranton, I. M. Dharmadasa, Next generation multilayer graded bandgap solar cells, Springer 2018 4. F. C. Kebs, Stability and degradation of organic and polymer solar cells, Wiley 2012 5. G. Lanzani, The photophysic behind photovoltaic and photonics, Wiley 2010
Supplementary literature	1. P. Wurfel, Physics of Solar Cells, Wiley-VCH, Weinheim, 2005
eResources addresses	Adresy na platformie eNauczanie: Konwersja Energii Słonecznej 2023-24 - Moodle ID: 37593 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=37593

Example issues/ example questions/ tasks being completed	1. Basic structure of photovoltaic cells 2. The concepts leading to increased efficiency of solar cells 3. The methods of storing thermal energy generated by solar radiation
Work placement	Not applicable

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