SYLLABUS

1. Information about the study programme

1.1 Institution of higher education	West University of Timisoara
1.2 Faculty	Faculty of Physics and Mathematics
1.3 Department of	PHYSICS
1.4 Field of study	PHYSICS
1.5 Study cycle	MASTER
1.6 Study programme	ADVANCED RESERCH METHODS IN PHYSICS / according to COR: Analyst - 251201; Research assistant in physics - 211103; Physicist - 211101; Teacher - 233002;

2. Information about the subject/discipline

2.1 Name			Solar Energy Conversion				
2.2 Course coordinator			Prof. dr. Eugenia Paulescu				
2.3 Seminar coordinator			Prof. dr. Eugenia Paulescu				
2.4 Year of study	2	**2.5 Semester**	1	**2.6 Type of assessment**	E[1]	**2.7 Type of discipline**	DOB

3. Total estimated time (hours of teaching per semester)[2]

3.1 Number of hours per week	4	**3.2 course**	2	**3.3 seminar/laboratory**	2
3.4 Total hours in the curriculum	56	**3.5 course**	28	**3.6 seminar/laboratory**	28
Distribution of time:					**hours**
Study based on Instructions, course materials, bibliography and notes					40
Additional documentation library, specialized electronic platforms / field					20
Training seminars / laboratories, homework, essays, portfolios and essays					30
Tutoring					
Examinations[3]					4
Other activities					
3.7 Total hours of individual study	94				
3.8 Total hours per semester[4]	150				
3.9 Number of credits	6				

[1] According to article 37, paragraph (1) of the Higher Education Law no. 199/2023, with subsequent amendments and additions, "the academic success of a student during a study program is determined by verifying the acquisition of the expected learning outcomes through exam-type evaluations and evaluation throughout the semester".

[2] The total number of contact hours and individual study hours will be aligned with the number of credits allocated to the course. One credit corresponds to a total between 25 and 30 hours of teaching activities and individual study. At the level of academic departments may establish, by discipline categories, the exact equivalence between one credit and the number of hours.

[3] The hours corresponding to examinations are added only to the point 3.8 – The total hours per semester, not to be added to the point 3.7 – Total hours of individual study.

[4] Total hours per semester = total hours in the curriculum + total hours of individual study + hours allocated to examinations.

4. Prerequisites (where applicable)

4.1 of curriculum	Mathematics, Computational physics, Solid State Physics
4.2 of skills	Basic knowledge about the numerical methods applied in physics

5. Conditions (where applicable)

5.1 for the course	Computer connected to the internet
5.2 for the seminar	Computer connected to the internet

6. Discipline objectives - expected learning outcomes which contribute to the completion and passing the discipline

Knowledge	Understanding the main themes from solar radiation physics. Explaining the quantities, concepts and phenomena in the field of solar radiation using terms, notions, theories, models, equations, schemes and graphical representations. Using computational methods for estimating the available solar energy in specific locations and the amount of electricity that can be obtained from it by photovoltaic conversion.
Skills	Basic data analysis knowledge. Accessing the BSRN, AERONET and other databases, selecting and sorting data. Using the R programming environment.
Responsibility and autonomy	Performing professional tasks efficiently and responsibly, with appropriate guidance when required. Applying effective teamwork and collaboration skills in the completion of assigned tasks. Using and critically evaluating information from relevant scientific sources in an international language. Developing a positive, responsible, and proactive attitude towards continuous professional development.

7. Contents

The platform through which the course materials in electronic format and other learning/bibliographic resources can be accessed: E-learning Platform

7.1 Course	**Teaching methods**	**Comments**
1. The solar energy flux in space	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
2. Extraterrestrial solar radiation. Earth and Sun geometry	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
3. Blackbody radiation. Planck's radiation law	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
4. Radiative transfer in the atmosphere	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform

5. Atmospheric transmittances. Absorption and scattering of solar radiation.	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
6. Solar radiation at the Earth surface. Direct, diffuse and global components	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
7. Light absorption. Photovoltaics effect.	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
8. Electrons in solids. Band diagrams. Density of states	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
9. Photovoltaic device	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
10.Current-voltage relation. Shockley equation and the equivalent circuit.	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
11. Parameters for an operating photovoltaic device	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
12. Irradiance-to-power conversion. Physical model chains	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
13. Current progress in PV conversion. Perovskite solar cells	Interactive lectures using a whiteboard.	Lecture notes available online on E-learning Platform
14. The spectral responses of different PV cells. Average photon energy. Spectral factor**.**	Interactive lectures using a whiteboard	Lecture notes available online on E-learning Platform

Bibliography:

- Michael E. Mackay, Solar Energy An Introduction, Oxford 2015.
- Muhammad Iqbal, An Introduction to Solar Radiation, Academic Press, 1983.
- K. N. Liou, An Introduction to Atmospheric Radiation, Second Edition, , Academic Press 2002.
- M. Paulescu, E. Paulescu, P. Gravila and V. Badescu, Weather modeling and forecasting of PV systems operation, Springer, 2013.
- V. Badescu, M. Paulescu (Ed) Spectral Characteristic of Solar Radiation Applications in Photovoltaic Conversion, Elsevier 2025.
- Jenny Nelson, The physics of solar cells, Imperial College Press, 2003.
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7.2. Seminar	**Teaching methods**	**Comments**
1. Calculation of zenith angle, solar azimuth, sunrise hour angle	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
2. Calculating the angle of incidence for a tilted surface	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform

3. Daily and Hourly irradiation on horizontal surface	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
4. Daily and Hourly irradiation on surface tilted toward equator	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
5. Estimation of Ground-Level Irradiance Components Using R	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
6. Spectral and broadband atmospheric transmittances	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
7. Implementing in R a parametric clear-sky model.	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
8. Electron in a periodic potential. Kronig-Penney model	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
9. Databases for radiometric measurements and atmospheric parameters	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
10. Current–voltage characteristic of a solar cell: a practical application	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
11. Datasheet parameter extraction for a PV module – practical application	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
12. Numerical modeling of a physical model chains – Writing the equations	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
13. Numerical modeling of a physical model chains. Part 2 – Solving the equations	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform
14. The spectral responses of different PV cells	Solving problems and simulations. Guidance.	Seminar support and solved problems are available online on E-learning Platform

Bibliography:

- Michael E. Mackay, Solar Energy An Introduction, Oxford 2015.
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- V. Badescu, M. Paulescu (Ed) Spectral Characteristic of Solar Radiation Applications in Photovoltaic Conversion, Elsevier 2025.
- Jenny Nelson, The physics of solar cells , Imperial College Press, 2003

8. Corroboration of the course contents with the epistemic expectations of the community representative, professional associations and representative employers of the programme itself

The course Solar energy conversion is a general physics course of which content has the role of standardizing and consolidating students' knowledge in the field of solar radiation and solid state physics. The focus on the physics of radiative transfer and irradiance-to-power conversion is of interest for employers both from research and industry.

9. Use of tools based on generative artificial intelligence

The use of generative artificial intelligence tools (e.g., ChatGPT, Google Gemini) is **not permitted during the assessment activities**. The assessment is conducted through a written examination, consisting of problem-solving tasks and theoretical questions, completed individually by the students without the use of generative AI tools.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final mark
10.4 Course	The assessment will focus on students' fundamental theoretical knowledge and their ability to solve physics problems.	Final exam. Written test consisting of questions and problems.	70 %
10.5 Seminar	The student solves seminar and homework problems, demonstrating the knowledge and skills required to analytically and/or numerically solve problems related to Sun–Earth geometry, atmospheric radiative transfer, irradiance component calculations, and current generation in silicon photovoltaic devices.	Ongoing assessment	30 %
10.6 Minimum performance standards			
Basic knowledge of solar energy flux estimation and its conversion into electricity. The student demonstrates the ability to solve problems similar to those addressed during the seminars.			

Date of submission: 15.09.2026 **Titular of the course**: Prof. dr. Eugenia Paulescu

Signature:

Date of approval in department:

Seminary titular: Prof. dr. Eugenia Paulescu

Signature: [redacted]

HEAD OF THE DEPARTMENT: