COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z-FT**	
Course title: **Advanced Numerical Methods in Physics (zaawansowane metody numeryczne w fizyce) (SPECJALNOŚCI / SPECJALIZACJE / MODUŁY SPECJALNOŚCIOWE)**	Course code: **SPR16AIIJ3445_26S**
Name of field of study: **fizyka**	
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic** / Specialty: **fizyka teoretyczna**
Course / module status **obligatory**	Language of instruction: **semester: 2 - english language**

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
1	2	conversation	15	0	pg	5
		laboratory	30	0	pg	
Total			**45**			**5**

Course / module coordinator	**dr hab. VINCENZO SALZANO**
Course instructor	**dr hab. VINCENZO SALZANO**
Course / module objectives	**To familiarize students with selected numerical methods used to solve advanced physical problems. Acquiring the ability to apply and implement selected methods to solve physical problems. Developing awareness of continuous learning and responsibility in the process of independent solving of numerical problems.**
Prerequisites	**Knowledge of linear algebra, mathematical analysis, principles and skills of structured and object-oriented programming. He is able to use scientific publications in a foreign language.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**The student defines, describes and characterizes advanced numerical methods.**	**K_W01 K_W02 K_W03 K_W09**
skills	**1**	**EP2**	**The student solves a computational problem using various numerical methods.**	**K_U02 K_U03 K_U04 K_U05**
	2	**EP3**	**The student programs numerical calculations, compares the obtained results and evaluates the usefulness of individual methods.**	**K_U04 K_U05 K_U09**
social competences	**1**	**EP4**	**The student is ready to learn and solve numerical problems independently.**	**K_K02 K_K03**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **Advanced Numerical Methods in Physics (zaawansowane metody numeryczne w fizyce)**			
Format of instruction: **conversation**			
1. **Minimization or maximization of functions**	2	3	0
2. **Fast Fourier Transform and spectral applications**	2	3	0
3. **Boundary-value problems for ordinary differential equations**	2	3	0
4. **Monte Carlo Markov Chains methods**	2	2	0
5. **Nested Sampling**	2	1	0

6. **Reconstruction methods: LOESS-SIMEX; Gaussian Processes**	2	2	0
7. **Principal Component Analysis**	2	1	0
Format of instruction: **laboratory**			
1. **Minimization or maximization of functions**	2	6	0
2. **Fast Fourier Transform and Spectral Applications**	2	6	0
3. **Boundary-value problems for ordinary differential equations**	2	6	0
4. **Markov chain Monte Carlos methods**	2	4	0
5. **Nested sampling**	2	2	0
6. **Reconstruction methods: LOESS-SIMEX; Gaussian Processes**	2	4	0
7. **Principal Component Analysis**	2	2	0

Modes of delivery	**A seminar using a multimedia presentation and a whiteboard in the computer lab. Discussion.** **Laboratory in the form of solving numerical problems in a computer lab (individual work).** The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	SPRAWDZIAN	**EP1,EP2,EP3,EP4**
	PROJEKT	**EP1,EP2,EP3**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP2,EP4**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	

Grading criteria	
	The course grade is a weighted average of the laboratory grades (40%) and the tutorial grades (60%).
	Grade calculation principles
	Assessment of the laboratory is based on successfully passing the tests, which include numerical problems. **The assessment is based on the percentage of points earned, using the following scale: 5.0 (very good): 91-100%; 4.5 (good plus): 81-90%; 4.0 (good): 71-80%; 3.5 (sufficient plus): 61-70%; 3.0 (sufficient): 51-60%; 2.0 (unsatisfactory): 0-50%.** **Assessment of the seminar is based on the project. Project Assessment:** **A 5.0 (very good): The project is fully functional, complex, well-thought-out, with a clear structure, meets all requirements, is well-documented, and easy to maintain.** **A 4.5 (good plus): The code is correct, contains minor inaccuracies, or can be improved. Score 4.0 (good): The project works as intended, although it may be less complex. The code structure is understandable, but the use of object-oriented features is partial or simplified.** **Score 3.5 (sufficient): The project demonstrates limited functionality. There may be gaps in the documentation or code structure.** **Score 3.0 (sufficient): The project meets the minimum functional requirements. The code is inconsistent or suboptimal, but allows for basic program operation. The student understands the main concepts, although they may have difficulty implementing them.** **Projects that do not meet the minimum requirements (lack of functionality, copying someone else's code) will not be passed and must be revised.**

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	2	Advanced Numerical Methods in Physics (zaawansowane metody numeryczne w fizyce)		Ważona	
	2	Advanced Numerical Methods in Physics (zaawansowane metody numeryczne w fizyce) [laboratorium]	zaliczenie z oceną		0,40
	2	Advanced Numerical Methods in Physics (zaawansowane metody numeryczne w fizyce) [konwersatorium]	zaliczenie z oceną		0,60

Basic reading	M. Hjorth-Jensen (2014): Computational Physics (Lecture Notes Fall 2014)
	Richard L. Burdenm J. Douglas Faires (2010): Numerical Analysis, Brooks/Cole CENGAGE Learning
	William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery (1997): Numerical Recipes in C, Cambridge University Press
Supplementary reading	

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**45**	**0**
Participation in test / exam	**0**	**0**
Preparation for contact hours	**22**	**0**
Private reading and studying	**20**	**0**
Participation in tutorials	**18**	**0**
Preparation of project / essay / etc.	**20**	**0**
Preparation for test / exam	**0**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-I-S-25/26Z**	
Course title: **astronomy (astronomia) (PODSTAWOWE)**	Course code: **SPR16AIJ3445_28S**
Name of field of study: **fizyka**	
Mode and cycle of study: **first-degree, full - time**	Profile of study: **general academic** / Specialty:
Course / module status **obligatory**	Language of instruction: **semester: 2 - english language, semester: 3 - english language**

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
1	2	lecture	15	0	pg	2
2	3	conversation	30	0	e	3
Total			**45**			**5**

Course / module coordinator	**prof. dr hab. EWA SZUSZKIEWICZ**
Course instructor	**prof. dr hab. EWA SZUSZKIEWICZ**
Course / module objectives	**A good understanding of the nature of astronomical phenomena and the underlying fundamental laws, correct use of astronomical terminology, acquire the ability to assess the current state of the astronomical research, develop the capacity of performing simple astronomical observations**
Prerequisites	**Basics of differential and integral calculus of functions of one and many variables; basics of an algebra to the extent necessary in the description of physical phenomena and solutions of physical problems; knowledge of laws of mechanics of a material point and a rigid body as well as relativistic mechanics; knowledge of laws of electricity and magnetism; ability to formulate basic physical laws using mathematical formalism; knowing the limitations of one's knowledge and an understanding the need for further education**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**A student understands the nature of astronomical phenomena and the underlying fundamental laws**	**K_W01 K_W07**
skills	**1**	**EP2**	**A student is able to use correctly the astronomical terminology,**	**K_U12 K_U16 K_U17 K_U18 K_U19 K_U22**
	2	**EP3**	**A student possesses the ability to assess the current state of the astronomical research**	**K_U12 K_U15 K_U16 K_U20 K_U22**
	3	**EP4**	**A student is able to perform simple astronomical observations**	**K_U02 K_U04 K_U09 K_U13 K_U16**
	4	**EP5**	**A student is able to discuss a particular problem with a group of her/his colleagues and remain open on their argumentations**	**K_U17 K_U21**
social competences	**1**	**EP6**	**A student understands a need to disseminate the knowledge of astronomy to a wide public, is ready to take part in the organisation of the public lectures, the night sky shows or other outreach events dedicated to astronomy**	**K_K04 K_K05**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **astronomy (astronomia)**			
Format of instruction: **lecture**			
1. **Contents of the Universe**	2	1	0
2. **Astronomical instrumentation**	2	1	0
3. **The Sun**	2	1	0
4. **Last stages of the stellar evolution**	2	1	0
5. **Evolution of low-mass stars**	2	1	0
6. **Evolution of massive stars**	2	1	0
7. **Binary stars**	2	1	0
8. **Accretion discs**	2	1	0
9. **Star systems**	2	1	0
10. **Interstellar medium**	2	1	0
11. **Normal and active galaxies**	2	1	0
12. **Systems of galaxies**	2	1	0
13. **Intergalactic medium and large scale structure**	2	1	0
14. **Planets and life**	2	1	0
15. **Astronomical essay**	2	1	0
Format of instruction: **conversation**			
1. **Getting to know the night sky**	3	3	0
2. **Measuring sizes and distances in astronomy**	3	3	0
3. **Observation of the Sun**	3	3	0
4. **Properties of stars**	3	3	0
5. **Evolution of stars**	3	3	0
6. **Accretion processes**	3	3	0
7. **Observations of stars**	3	4	0
8. **Planets**	3	4	0
9. **Observations of planets**	3	4	0

Modes of delivery	**lecture with multimedia computer presentations, observations using amateur reflecting telescopes, Solar observations, evening sky observations using maps, star atlases and catalogs**
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN PISEMNY	**EP1,EP2,EP3,EP4,EP5,EP6**
	PROJEKT	**EP1,EP2,EP4,EP6**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP5**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	
Grading criteria	**discussion session: passing the written exam lecture: obtaining a credit from the oral test, being active during the classes**	
	Grade calculation principles	
	The mark from the exam makes the final grade. There is a possibility to increase the final grade if the student is active during the classes	

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	2	astronomy (astronomia)		Ważona	
	2	astronomy (astronomia) [wykład]	zaliczenie z oceną		1,00
	3	astronomy (astronomia)		Ważona	
	3	astronomy (astronomia) [konwersatorium]	egzamin		1,00

Basic reading	Shu Frank H. (2003): Galaktyki Gwiazdy Życie, Fizyka Wszechświata, Prószyński i S-ka, Warszawa
	teksty źródłowe podawane na wykładzie :
Supplementary reading	Artymowicz P. (1995): Astrofizyka układów planetarnych, PWN, Warszawa
	Jaroszyski M. (1993): Galaktyki i Budowa Wszechświata, PWN, Warszawa
	Kreiner J. M. (1992): Astronomia z astrofizyką, PWN, Warszawa
	Kubiak M. (1994): Gwiazdy i materia międzygwiazdowa, PWN, Warszawa

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**45**	**0**
Participation in test / exam	**5**	**0**
Preparation for contact hours	**15**	**0**
Private reading and studying	**20**	**0**
Participation in tutorials	**15**	**0**
Preparation of project / essay / etc.	**10**	**0**
Preparation for test / exam	**15**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z-FT**	
Course title: **Astrophysics (astrofizyka) (SPECJALNOŚCI / SPECJALIZACJE / MODUŁY SPECJALNOŚCIOWE)**	Course code: **SPR16AIIJ3445_24S**
Name of field of study: **fizyka**	
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic** / Specialty: **fizyka teoretyczna**
Course / module status: **obligatory**	Language of instruction: **semester: 2 - english language**

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
1	2	conversation	30	0	pg	4
Total			**30**			**4**

Course / module coordinator	**prof. dr hab. EWA SZUSZKIEWICZ**
Course instructor	**prof. dr hab. EWA SZUSZKIEWICZ**
Course / module objectives	**Application of physical methods to the interpretation of astronomical phenomena; gaining the ability to construct theoretical models; strengthening knowledge on the analytical and numerical methods, using as an example the simple models of the stellar structure and a critical approach to the results of research. Acquiring teamwork skills.**
Prerequisites	**Familiarity with the differential calculus: derivatives and integrals of one and more variables, basic knowledge of Algebra, necessary to describe the physical phenomena and solve physical problems; familiarity with the laws of motion of the pointlike masses and rigid bodies, as well as relativistic mechanics; knowlwdge of basic laws in electricity and magnetism, Maxwell equations; knowledge of astronomy on the level required in the first year undergraduate Physics studies ability to formulate basic physical laws using mathematical apparatus; awareness of the limitations of the own knowledge and understanding of the need to learn more.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**The student is familiar with the analytical and numerical methods used in Astrophysics.**	**K_W02 K_W03 K_W09**
skills	**1**	**EP2**	**The student has the ability to apply the physical laws to the interpretation of astronomical phenomena.**	**K_U02 K_U05**
	2	**EP3**	**The student is able to construct theoretical models.**	**K_U01 K_U02 K_U04**
	3	**EP4**	**The student is able to compare theoretical models with the observations.**	**K_U04 K_U05**
	4	**EP5**	**The student discusses with the group of colleagues a given prroblem and remains open for the arguments of others.**	**K_U07**
social competences	**1**	**EP6**	**The student is ready to broaden the knowledge about the astrophysical processes, gain new information and assess the information critically. The student understands the importance of an exchange of ideas in the process of gaining knowledge.**	**K_K02 K_K03**

CONTENT	Semester	No. of hours	including e-learning

Subject title: **Astrophysics (astrofizyka)**

Format of instruction: **conversation**

1. **Stellar structure modelling.**	2	20	0
2. **Radiative processes in Astrophysics**	2	10	0

Modes of delivery	**multimedia computer presentations, computer laboratory use to perform tasks connected with numerical modelling, presentations of the most recent astronomical discoveries, finding solution to the given problems, collaborative work**
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	PRACA PISEMNA/ ESEJ/ RECENZJA	**EP1,EP2,EP3,EP4,EP5,EP6**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP5,EP6**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	

Grading criteria	**indepenent implementation of the project, discussion and comparison of the obtained results with other students, preparation of a written report with the results of the project**
	Grade calculation principles
	The final mark will be given on the basis of the report with the results of the project

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	2	Astrophysics (astrofizyka)		Ważona	
	2	Astrophysics (astrofizyka) [konwersatorium]	zaliczenie z oceną		1,00

Basic reading	Kippenhahn R., Weigert A., Weiss A. (2012): Stellar structure and evolution, Springer-Verlag, Berlin Heidelberg
	Rybicki G. B., Lightman A. P (2024): Radiation processes in astrophysics, Wiley-VCH, Berlin
	current literature given during the course
Supplementary reading	Many of the stellar course notes are provided by Jeremy Goodman and Bohdan Paczynski : Stars and star formation (lectures at the Princeton University), https://www.astro.princeton.edu/~gk/A403/notes.html

STUDENT WORKLOAD

	No. of hours	including e-learning
Contact hours	**30**	**0**
Participation in test / exam	**0**	**0**
Preparation for contact hours	**15**	**0**
Private reading and studying	**15**	**0**
Participation in tutorials	**20**	**0**
Preparation of project / essay / etc.	**20**	**0**
Preparation for test / exam	**0**	**0**
TOTAL workload	**100**	
ECTS credits	**4**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-I-S-25/26Z**		
Course title: **Introduction to Thermodynamics and Statistical Physics (wprowadzenie do termodynamiki i fizyki statycznej) (PODSTAWOWE)**		Course code: **SPR16AIJ3445_3S**
Name of field of study: **fizyka**		
Mode and cycle of study: **first-degree, full - time**	Profile of study: **general academic**	Specialty:
Course / module status **obligatory**	Language of instruction: **semester: 3 - english language**	

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
2	3	discussion classes	30	0	pg	5
		lecture	15	0	e	
Total			**45**			**5**

Course / module coordinator	**dr hab. FRANCO FERRARI**
Course instructor	**dr hab. FRANCO FERRARI**
Course / module objectives	**After the course will be completed, student should understand the laws and methods of thermodynamics. They should also be able to apply to physical problems the methods of classical statistical mechanics**
Prerequisites	**Basics of physics**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**A student knows basic concepts and laws of thermodynamics: can describe phenomena and processes in thermodynamics, and statistical physics.**	**K_W11**
	2	**EP2**	**A student has general knowledge of the basic concepts, principles and theories relevant to thermodynamics and statistical physics.**	**K_W01 K_W14**
skills	**1**	**EP3**	**A student is able to formulate basic physical laws using mathematical formalism.**	**K_U01 K_U03**
	2	**EP4**	**A student is able to use mathematical apparatus and mathematical methods to describe, and model phenomena, and physical processes.**	**K_U05**
	3	**EP6**	**A student is able to present detailed issues of thermodynamics and statistical physics.**	**K_U19**
social competences	**1**	**EP5**	**A student is ready to critically evaluate the information received. A student is ready to discuss basic physical problems and theories related to thermodynamics and statistical physics that concern public opinion, such as: economic and environmentally friendly energy sources and heating methods, the importance of entropy and information.**	**K_K01 K_K05**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **Introduction to Thermodynamics and Statistical Physics (wprowadzenie do termodynamiki i fizyki statycznej)**			
Format of instruction: **lecture**			
1. **Thermodynamics**	3	8	0

2. **Statistical physics**	3	7	0
Format of instruction: **discussion classes**			
1. **Exercises in thermodynamics and statistical physics**	3	25	0
2. **Presentations**	3	5	0

Modes of delivery	**During the lectures, the knowledge of thermodynamics acquired after completing the basic physics course will be extended. In addition, the basics of statistical physics will be introduced. An overview of the applications of thermodynamics and statistical physics will also be presented, and contemporary progress in these fields will be discussed. The student will deepen his knowledge of the concepts and methods of thermodynamics and statistical physics through exercises conducted individually or in a group during the seminar hours. Each student will prepare a presentation at home on a given topic in thermodynamics or statistical physics and present it at the end of the academic semester during tutorial hours. Lectures will be available on the course website.**
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN PISEMNY	**EP1,EP2,EP3,EP4**
	KOLOKWIUM	**EP1,EP2,EP3,EP4**
	PREZENTACJA	**EP1,EP2,EP6**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP5**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	

Grading criteria	**Lecture: passing an exam in the form of a written exam;** **exercises: passing one test;** **presentation: quality of answers to questions after the presentation;** **The final grade is a weighted average of the exam, presentation and test.** **OK = OE*40% + OK * 40% + OP *20%** **where: OK = final grade, OE = exam grade, OK = test grade, OP = presentation grade**
	Grade calculation principles
	The final grade is a weighted average of the grade from the lecture (40%) and exercises (60%)

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	3	Introduction to Thermodynamics and Statistical Physics (wprowadzenie do termodynamiki i fizyki statycznej)		Ważona	
	3	Introduction to Thermodynamics and Statistical Physics (wprowadzenie do termodynamiki i fizyki statycznej) [ćwiczenia]	zaliczenie z oceną		0,40
	3	Introduction to Thermodynamics and Statistical Physics (wprowadzenie do termodynamiki i fizyki statycznej) [wykład]	egzamin		0,60

Basic reading	Kerson Huang (2006): Podstawy Fizyki Statystycznej, Wydawnictwo Naukowe PWN, Warszawa
	Slajdy i notatki z wykładów umieszczone na stronie internetowej przedmiotu
Supplementary reading	Kerson Huang (1987): Mechanika statystyczna, Wydawnictwo Naukowe PWN, Warszawa
	M. W. Zemansky (1957): Heat and Thermodynamics, McGraw-Hill, New York

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**45**	**0**
Participation in test / exam	**6**	**0**
Preparation for contact hours	**8**	**0**
Private reading and studying	**17**	**0**

Participation in tutorials	**13**	**0**
Preparation of project / essay / etc.	**10**	**0**
Preparation for test / exam	**26**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z**		
Course title: **Mathematical Methods of Physics II (metody matematyczne fizyki II) (PODSTAWOWE)**		Course code: **SPR16AIIJ3445_7S**
Name of field of study: **fizyka**		
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic**	Specialty:
Course / module status **obligatory**	Language of instruction: **semester: 1 - english language**	

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
1	1	discussion classes	30	0	pg	5
		lecture	30	0	e	
Total			**60**			**5**

Course / module coordinator	**dr hab. FRANCO FERRARI**
Course instructor	**dr hab. VINCENZO SALZANO**
Course / module objectives	**Ability of applying the advanced mathematical methods that are used in physics.**
Prerequisites	**Knowledge of mathematical methods of physics I.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP4**	**The student knows and understands in depth the methods, research tools and mathematical models used in physics including those within the scope of the chosen specialization, enabling the analysis, description and interpretation of complex physical phenomena**	**K_W01**
skills	**1**	**EP5**	**The student is able to prepare oral presentations and written studies presenting specialist topics in the field of statistical physics in a communicative manner, as well as to conduct debates on such topics**	**K_U09**
social competences	**1**	**EP6**	**is ready to appreciate the role of knowledge in solving cognitive and practical problems and to use the opinions and advice of experts, also from other disciplines, in situations requiring an interdisciplinary approach or exceeding one's own competences**	**K_K03**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **Mathematical Methods of Physics II (metody matematyczne fizyki II)**			
Format of instruction: **lecture**			
1. **Partial differential equations**	1	10	0
2. **Tensor analysis**	1	10	0
3. **Functional analysis**	1	10	0
Format of instruction: **discussion classes**			

1. **Partial Differential Equations**	1	10	0
2. **Exercises about the part of the course on tensor calculus**	1	10	0
3. **Exercises about the part of lectures dedicated to functional analysis**	1	10	0

Modes of delivery	**Wykłady konwencjonalny z przykładami. Praca w grupach i indywidualnie podczas wykonywania ćwiczeń. Szczególna uwaga będzie położona na aspekty interdyscyplinarne.**
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	KOLOKWIUM	**EP4,EP6**
	PREZENTACJA	**EP4,EP5,EP6**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	

Grading criteria	**Wykład: zdanie egzaminu w postaci egzaminu pisemnego** **Ćwiczenia: zaliczenie dwóch kolokwiów.** **Ocena końcowa z modułu jest średnią ważoną ocen z egzaminu oraz ćwiczeń**
	Grade calculation principles
	FS = 60% * SE1 + 40% * SE2 **gdzie:** **FS= ocena końcowa, SE1 = ocena z egzaminu, SE2 = ocena z ćwiczeń**

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	1	Mathematical Methods of Physics II (metody matematyczne fizyki II)		Arytmetyczna	
	1	Mathematical Methods of Physics II (metody matematyczne fizyki II) [ćwiczenia]	zaliczenie z oceną		
	1	Mathematical Methods of Physics II (metody matematyczne fizyki II) [wykład]	egzamin		

Basic reading	A. Lichnerowicz (2016): Elements of tensor calculus, Dover Publictions Inc., Mineola, New York
	C. Walck (2007): Handbook on Statistical Distributions for Experimentalists, International Report SUF-PFY/96-01; University of Stockholm, Stockholm, Sweden, 2007
	G.B. Arfken, H.J. Weber, F.E. Harris (2012): Mathematical Methods for Physicists: A Comprehensive Guide, Academic Press
	J. Zinn-Justin (1993): Quantum Field Theory and Critical Phenomena, Clarendon Press, Oxford
	R. C. Clark, G. H. Derrick (Editorzy) (1968): Mathematical methods in solid state and superfluid theory, Springer Science + Business Media, New York
	V. I. Arnold (1989): Mathematical methods of classical mechanics, 2nd edition, Springer Verlag, New York
Supplementary reading	Kenneth Lang (1974): Astrophysical formulae, Springer Verlag, Berlin, Heidelberg, New York

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**60**	**0**
Participation in test / exam	**0**	**0**
Preparation for contact hours	**20**	**0**
Private reading and studying	**5**	**0**
Participation in tutorials	**15**	**0**
Preparation of project / essay / etc.	**10**	**0**

Preparation for test / exam	**15**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z**		
Course title: **Statistical Physics II (fizyka statystyczna II) (KIERUNKOWE)**		Course code: **SPR16AIIJ3445_8S**
Name of field of study: **fizyka**		
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic**	Specialty:
Course / module status **obligatory**	Language of instruction: **semester: 1 - english language**	

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
1	1	discussion classes	30	0	pg	5
		lecture	30	0	e	
Total			**60**			**5**

Course / module coordinator	**dr hab. FRANCO FERRARI**
Course instructor	**dr hab. FRANCO FERRARI**
Course / module objectives	**The purpose of this course is to deepen the student's knowledge in the subject of statistical physics and its applications.** **The student should be able to use mathematical tools and the methods of statistical physics in order to describe physical phenomena and processes of systems containing a large number of particles, atoms or molecules.** **The students understands the necessity of further education and is ready to a critical evaluation of the received information.**
Prerequisites	**Knowledge of thermodynamics, statistical physics I, quantum mechanics, mathematical methods of physics.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**Students will deepen their knowledge in the subject of statistical physics. They will be acquainted with the concepts of thermodynamics and will be able to describe thermodynamic processes and phenomena using the methods of statistical physics. They acquire knowledge on the analytical methods of statistical physics needed to solve problems in the case of simple quantum systems.**	**K_W02**
skills	**1**	**EP2**	**After the completion of the course the students acquire skills in applying the mathematical apparatus and the methods of statistical physics in order to model the physical phenomena and processes undergoing in systems containing a large number of particles. They will be able to prepare and give oral presentations about statistical physics. Students should also be skilled in reading and understanding scientific articles on statistical physics.**	**K_U01**
social competences	**1**	**EP3**	**Students understand the need of continuously update their knowledge and are ready to a critical analysis of the received information; they also recognize the necessity of improving their understanding of the physical world that surrounds them filling the gaps of their knowledge**	**K_K02**

CONTENT	Semester	No. of hours	including e-learning

Subject title: **Statistical Physics II (fizyka statystyczna II)**			
Format of instruction: **lecture**			
1. **Quantum statistical mechanics: postulates of equal prior probability and random phases, density matrix and density operator, quantum microcanonical, canonical, and grand canonical ensembles, derivation of thermodynamics, laws of thermodynamics.**	1	10	0
2. **Quantum statistics: perfect quantum gases, Bose-Einstein and Fermi-Dirac statistics, representation of population numbers, formulas for statistical sums, equation of state, mean, number of particles, perfect Fermi gas, perfect Bose gas, internal energy and equation of state.**	1	10	0
3. **Scaling laws and phase transitions. Scaling theories in polymer physics. Phase transitions and Ginzburg-Landau models.**	1	10	0
Format of instruction: **discussion classes**			
1. **Quantum statistical mechanics.**	1	10	0
2. **Quantum statistics**	1	10	0
3. **Scaling laws and phase transitions**	1	10	0

Modes of delivery	**Informative lecture using multimedia presentation and whiteboard. Discussion., Calculus and problem-solving exercises**	
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.	
Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN PISEMNY	**EP1**
	KOLOKWIUM	**EP1,EP2**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	
Grading criteria	**The condition for passing the exercises is a positive score of the colloquium.** **The condition for passing the lecture is a positive grade in the written exam.** **Grade for the colloquium and exam is based on the following scale: 5.0 - at least 91 points, 4.5 - at least 81 points, 4.0 - at least 71 points, 3.5 - at least 61 points, 3.0 - at least 51 points, 2.0 - less than 51 points.**	
	Grade calculation principles	
	The course grade is the arithmetic average of the final grades from the tutorials and lecture.	

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	1	Statistical Physics II (fizyka statystyczna II)		Arytmetyczna	
	1	Statistical Physics II (fizyka statystyczna II) [wykład]	egzamin		
	1	Statistical Physics II (fizyka statystyczna II) [ćwiczenia]	zaliczenie z oceną		

Basic reading	Kerson Huang (2006): Podstawy Fizyki Statystycznej, Wydawnictwo Naukowe PWN, Warszawa
	Mehran Kardar (2007): Statistical Physics of Particles, Cambridge University Press
Supplementary reading	L. Colombo (2022): Statistical Physics of Condensed Matter Systems, IOP Publishing, Bristol

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**60**	**0**
Participation in test / exam	**2**	**0**
Preparation for contact hours	**20**	**0**
Private reading and studying	**20**	**0**
Participation in tutorials	**3**	**0**

Preparation of project / essay / etc.	**0**	**0**
Preparation for test / exam	**20**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z-FT**	
Course title: **fizyka biologiczna (SPECJALNOŚCI / SPECJALIZACJE / MODUŁY SPECJALNOŚCIOWE)**	Course code: **SPR16AIIJ3445_25S**
Name of field of study: **fizyka**	
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic** / Specialty: **fizyka teoretyczna**
Course / module status: **obligatory**	Language of instruction: **semester: 2 - polish language**

Year	Semester	Form of instruction	No. of hours	including e-learning	Type of credit	ECTS
1	2	conversation	30	0	pg	5
		lecture	15	0	pg	
Total			**45**			**5**

Course / module coordinator	**dr hab. FRANCO FERRARI**
Course instructor	**dr hab. FRANCO FERRARI**
Course / module objectives	**Familiarization with selected issues of biophysics as an interdisciplinary field combining physics and biology, in particular the mechanisms of phenomena occurring in living organisms at the molecular level and selected issues of bioinformatics, nanotechnology and diagnostics. Acquiring the ability to use physical and mathematical tools to describe and analyze biological processes at the molecular level, as well as to interpret basic data used in bioinformatics, nanotechnology and diagnostics. Acquiring a readiness to recognize the importance of an interdisciplinary approach in the natural sciences and to responsibly use biophysical knowledge in the context of diagnostic and technological applications.**
Prerequisites	**Knowledge and skills in mathematics, general physics, chemistry and biology at a basic level.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**The stdents knows and understands in depth the facts, phenomena, concepts and theories specific to biological physics, as well as the complex relationships and dependencies between them, encompassing both advanced general knowledge of the physical sciences applied to the description of living matter and in-depth detailed knowledge in selected areas of the discipline and specialization**	**K_W01**
skills	**1**	**EP2**	**The student is able to formulate, verify and test research hypotheses regarding complex problems in the field of biologtical physics, as well as plan and implement scientific research using observations,**	**K_U04**
social competences	**1**	**EP3**	**The student s ready to appreciate the role of knowledge in solving cognitive and practical problems and to use the opinions and advice of experts, also from other disciplines, in situations requiring an interdisciplinary approach or exceeding one's own competences**	**K_K03**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **fizyka biologiczna**			
Format of instruction: **lecture**			
1. **Overview of topics related to biological physics**	2	3	0

2. **Chemical bonds**	2	3	0
3. **Physics of DNA**	2	5	0
4. **Physics of proteins**	2	4	0
Format of instruction: **conversation**			
1. **Numerical and analytical exercises on biological physics. Solving problems in bioinformatics, particularly using the concept of Shannon entropy.**	2	30	0

Modes of delivery	**Analytical exercises: approximately 30 minutes of introduction to a given topic + approximately one hour to solve a problem related to the topic.** **Numerical exercises: approximately 30 minutes of introduction + approximately two or more hours to solve a given problem at least partially.** **Presentation: During the course of the work, the student prepares and presents a presentation on an interesting topic in biological physics.** **Lectures: Thematic lectures on DNA physics, protein physics, and DNA applications in nanotechnology.**
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	PREZENTACJA	**EP1**
	PROJEKT	**EP1,EP2,EP3**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	

Grading criteria	**Students have to obtain a positive score both for the presentation and for the project** **The presentation and the project is assessed based on the points obtained according to the following scale: Assessment 5.0 - at least 91 points, assessment 4.5 - at least 81 points, assessment 4.0 - at least 71 points, assessment 3.5 - at least 61 points, assessment 3.0 - at least 51 points, assessment 2.0 - less than 51 points.**
	Grade calculation principles
	arithmetic average of all completed classes (lecture and seminar)

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	2	fizyka biologiczna		Arytmetyczna	
	2	fizyka biologiczna [wykład]	zaliczenie z oceną		
	2	fizyka biologiczna [konwersatorium]	zaliczenie z oceną		

Basic reading	Rodney M. J. Cotterill (2002): Biophysics An Introduction, John Wiley & Sons, LTD, Padstow, Cornwall, Wielka Brytania
Supplementary reading	Genowefa Ślusarek (2011): Biofizyka molekularna, PWN, Warszawa

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**45**	**0**
Participation in test / exam	**0**	**0**
Preparation for contact hours	**25**	**0**
Private reading and studying	**20**	**0**
Participation in tutorials	**15**	**0**
Preparation of project / essay / etc.	**20**	**0**
Preparation for test / exam	**0**	**0**

TOTAL workload	**125**
ECTS credits	**5**

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z-ZF**	
Course title: **fizyka jądra atomowego i cząstek elementarnych (SPECJALNOŚCI / SPECJALIZACJE / MODUŁY SPECJALNOŚCIOWE)**	Course code: **SPR16AIIJ3445_12S**
Name of field of study: **fizyka**	
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic**
Specialty: **zastosowanie fizyki**	
Course / module status **obligatory**	Language of instruction: **semester: 2 - polish language**

Year	Semester	Form of instruction	No. of hours		Type of credit	ECTS
				including e-learning		
1	2	conversation	45	0	e	5
Total			**45**			**5**

Course / module coordinator	**dr hab. MARCIN PIĄTEK**
Course instructor	**dr hab. MARCIN PIĄTEK**
Course / module objectives	**zapoznanie studentów z pogłębionymi metodami teoretycznymi i eksperymentalnymi fizyki jądrowej oraz jej zastosowań w medycynie, badaniach materiałowych, energetyce i astrofizyce**
Prerequisites	**zna podstawy rachunku różniczkowego i całkowego funkcji jednej i wielu zmiennych; zna podstawy algebry w zakresie niezbędnym do opisu zjawisk fizycznych i rozwiązywania problemów fizycznych; zna aparat matematyczny mechaniki kwantowej oraz podstawowe prawa i zjawiska fizyki jądra atomowego i cząstek elemntarnych; zna ograniczenia własnej wiedzy i rozumie potrzebę dalszego kształcenia**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	**1**	**EP1**	**student potrafi opisać strukturę jądra atomowego w stanie podstawowym i wzbudzonym, rozróżnia między wzbudzeniami kolektywnymi i jednocząstkowymi, zna opis kwantowy rozpadów promieniotwórczych i reakcji jądrowych, zna podstawowe modele reakcji jądrowych i rozpraszania elastycznego**	**K_W01 K_W02**
	2	**EP2**	**student rozumie metody eksperymentalne i teoretyczne fizyki jądrowej stosowane w medycynie i w badaniach materiałowych, potrafi opisać reakcje jądrowe zachodzące we wnętrzu gwiazd prowadzące do powstania pierwiastków chemicznych we wszechświecie, rozumie koncepcje zastosowania reakcji jądrowych dla celów energetycznych, zna konstrukcje prostych reaktorów jądrowych**	**K_W01**

skills	**1**	**EP3**	**student potrafi przeprowadzić proste rachunki kwantowomechaniczne w ramach modelu deuteronu i modelu Fermiego jądra atomowego, potrafi zastosować reguły wyboru dla opisu rozpadów promieniotwórczych i wytłumaczyć obserwowane różnice ilościowe, potrafi zastosować zasady kinematyki reakcji jądrowych dla ich opisu, posiada umiejętność opisu różnych mechanizmów reakcji jądrowych, umie uwzględnić procesy tunelowania bariery kulombowskiej dla reakcji podbarierowych**	**K_U05 K_U06**
	2	**EP4**	**student posiada umiejętność zastosowania zasad fizyki jądrowej dla badań materiałowych, potrafi przedstawić podstawy fizyczne używanych technik jądrowych dla diagnostyki medycznej i radioterapii, potrafi zastosować metody wykorzystania reakcji jądrowych dla celów energetyki jądrowej, potrafi przedstawić sposoby syntezy pierwiastków chemicznych we wnętrzu gwiazd i w Wielkim Wybuchu**	**K_U01 K_U07**
social competences	**1**	**EP5**	**student ma swiadomość roztrzygajacej roli eksperymentu w weryfikacji modeli fizycznych i zna ograniczenia swojej wiedzy**	**K_K01 K_K02**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **fizyka jądra atomowego i cząstek elementarnych**			
Format of instruction: **conversation**			
1. **Introduction to Nuclear Physics and Fundamental Interactions**	2	4	0
2. **Structure and Properties of Atomic Nuclei**	2	6	0
3. **Nuclear Reactions**	2	6	0
4. **Introduction to Elementary Particle Physics**	2	6	0
5. **Weak Interaction and Neutrino Physics**	2	4	0
6. **Strong Interaction and Quantum Chromodynamics**	2	4	0
7. **Detection of nuclear radiation and elementary particles**	2	5	0
8. **Selected Topics in Contemporary High-Energy Physics**	2	5	0
9. **Applications and Perspectives**	2	5	0

Modes of delivery	**wykład informacyjny- prowadzony metodą tradycyjną przy tablicy i prezentacja multimedialna**	
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.	
Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN PISEMNY	**EP1,EP2,EP3,EP4**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP1,EP2,EP3,EP4,EP5**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	
Grading criteria	**zdanie egzaminu w postaci testu wyboru i egzaminu pisemnego**	
	Grade calculation principles	
	ocena końcowa jest średnią ocen z testu i egzaminu	

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	2	fizyka jądra atomowego i cząstek elementarnych		Ważona	
	2	fizyka jądra atomowego i cząstek elementarnych [konwersatorium]	egzamin		1,00

Basic reading	Araminowicz J. (1977): Zbiór zadań z fizyki jądrowej, PWN, Warszawa
	Heyde K. (1994): Basic Ideas and Concepts in Nuclear Physics, IOP Publishing Ltd
	Irodow I. (1974): Zadania z fizyki atomowej i jądrowej, PWN, Warszawa
	Mayer-Kuckuk T. (1987): Fizyka jądrowa, PWN, Warszawa
	Rolfs C., Rodney W. (1988): Cauldrons in the Cosmos, The University of Chicago Press
	Strzałkowski A. (1978): Wstęp do fizyki jądra atomowego, PWN, Warszawa
Supplementary reading	Prezentacja wykładu w formacie PowerPoint

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**45**	**0**
Participation in test / exam	**5**	**0**
Preparation for contact hours	**20**	**0**
Private reading and studying	**20**	**0**
Participation in tutorials	**15**	**0**
Preparation of project / essay / etc.	**10**	**0**
Preparation for test / exam	**10**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USSPR-F-O-II-S-26/27Z**		
Course title: **wybrane zagadnienia fizyki współczesnej (PODSTAWOWE)**		Course code: **SPR16AIIJ3445_3S**
Name of field of study: **fizyka**		
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic**	Specialty:
Course / module status **obligatory**	Language of instruction: **semester: 1 - polish language**	

Year	Semester	Form of instruction	No. of hours		Type of credit	ECTS
				including e-learning		
1	1	conversation	45	0	pg	5
Total			**45**			**5**

Course / module coordinator	**dr hab. MARCIN PIĄTEK**
Course instructor	**dr hab. MARCIN PIĄTEK**
Course / module objectives	**The aim of the course is to deepen and broaden students' knowledge of the most important and current areas of contemporary physics.**
Prerequisites	**Solid knowledge of general physics, including mechanics, electrodynamics, quantum mechanics, and statistical physics, at the level of a completed first-cycle degree. Basic knowledge of mathematical methods in physics, including differential and integral calculus, linear algebra, and differential equations.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	1	EP1	**knows and is able to characterize the main contemporary research areas in physics (condensed matter, quantum technologies, particle physics, astrophysics and cosmology, complex systems) and their basic concepts and research problems**	**K_W01 K_W02 K_W03 K_W04 K_W05 K_W09**
	2	EP2	**understands the theoretical foundations of selected issues (e.g. the concept of topology in quantum phases, the foundations of the Standard Model, mechanisms of superconductivity, principles of gravitational wave detection) and knows the important experimental measurement techniques used in these fields**	**K_W01 K_W02 K_W03 K_W04 K_W05 K_W09**
	3	EP3	**knows the current challenges and directions of development in selected fields of modern physics and is able to relate them to existing theoretical models and experimental methods**	**K_W01 K_W02 K_W03 K_W04 K_W05 K_W09**
skills	1	EP4	**can critically read and synthesize scientific literature (review and research articles) and formulate short reviews and summaries of results**	**K_U03 K_U04 K_U06 K_U08 K_U09**
	2	EP5	**is able to present (orally and in writing) the results of the analysis of a selected scientific article or mini-project: present the research aim, methodology, main results and their interpretation**	**K_U03 K_U06 K_U09**

social competences	**1**	**EP6**	**develops the ability to work independently in research: is able to plan and implement a short research project and present its results in a form understandable to the scientific community**	**K_K02 K_K03 K_K04**
	2	**EP7**	**is able to communicate technical and scientific results within a team and participate in scientific discussions, demonstrating the ability to argue and critically evaluate evidence**	**K_K02 K_K04**
	3	**EP8**	**demonstrates an open attitude towards interdisciplinary research approaches and awareness of the ethical and social aspects of technology development resulting from research in modern physics**	**K_K01 K_K03**

CONTENT	Semester	No. of hours	including e-learning
Subject title: **wybrane zagadnienia fizyki współczesnej**			
Format of instruction: **conversation**			
1. **Condensed matter and quantum material physics**	1	9	0
2. **Quantum physics and quantum technologies**	1	9	0
3. **High-energy physics, particles and fundamental interactions**	1	9	0
4. **Modern astrophysics and cosmology**	1	9	0
5. **Complex, nonlinear systems and interdisciplinary areas of physics**	1	9	0

Modes of delivery	**Individual or group mini-projects: literature review, preliminary theoretical or simulation analysis., A conversational lecture using multimedia presentations and short theoretical arguments.** **Problem-based introductions at the beginning of the thematic block., Student seminars: presentations of selected topics by students, with moderated group discussion., Analysis and critique of scientific articles. Case studies.**
	The course teacher shall specify how artificial intelligence should be used as part of implementation of the course according to University of Szczecin best practices and standards. The course teacher shall inform students in their first class about the scope and possibilities of using AI and shall present a catalogue of tools and applications adjusted to relevant learning outcomes and teaching needs and possibilities within a given course.

Assessment methods		No. of learning outcome from the syllabus
	PREZENTACJA	**EP1,EP2,EP3,EP4,EP5,EP6,EP7,EP8**
	PROJEKT	**EP1,EP2,EP3,EP4,EP5,EP6,EP7,EP8**
	Metody i formy weryfikacji efektów uczenia się mogą zostać zmienione dla studentów ze szczególnymi potrzebami na warunkach i zasadach określonych w Regulaminie Studiów Uniwersytetu Szczecińskiego.	

Grading criteria	**The final grade for the course is based on two components: 1. oral (seminar) presentation - 50 percent of the final grade; 2. mini-project (report + discussion) - 50 percent of the final grade. To pass the course, you must obtain a minimum of 50 percent of the total points and successfully complete both assessment components.**
	Grade calculation principles
	Grading scale in percentage points: **100-90 - very good (5.0)** **80-89 - good plus (4.5)** **70-79 - good (4.0)** **60-69 - satisfactory plus (3.5)** **51-59 - satisfactory (3.0)** **0-50 - unsatisfactory (2.0)**

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	1	wybrane zagadnienia fizyki współczesnej		Ważona	
	1	wybrane zagadnienia fizyki współczesnej [konwersatorium]	zaliczenie z oceną		1,00

Basic reading	Rudolf Kippenhahn, Alfred Weigert, Achim Weiss : Stellar Structure and Evolution , (Astronomy and Astrophysics Library) 2nd ed. 2012 Edition
	Andrew Liddle (2015): An Introduction to Modern Cosmolog
	D. Griffiths : Introduction to Elementary Particles, Wiley-VCH.
	N.W. Ashcroft, N.D. Mermin : Solid State Physics, Brooks Cole
	S.M. Carroll : Spacetime and Geometry: An Introduction to General Relativity, Cambridge University Press
	Tudor D. Stanescu : Introduction to Topological Quantum Matter & Quantum Computation
Supplementary reading	

STUDENT WORKLOAD

	No. of hours	
		including e-learning
Contact hours	**45**	**0**
Participation in test / exam	**5**	**0**
Preparation for contact hours	**25**	**0**
Private reading and studying	**20**	**0**
Participation in tutorials	**15**	**0**
Preparation of project / essay / etc.	**10**	**0**
Preparation for test / exam	**5**	**0**
TOTAL workload	**125**	
ECTS credits	**5**	