# ASTRONOMY

SECOND DEGREE STUDIES

COURSE DIRECTORY

# ENGLISH AS A FOREIGN LANGUAGE

# ASTRONOMY

Course code:**09.0-WFiA-AST-JA**

Type of course:**compulsory**

Language of instruction:**english/polish**

Director of studies:**mgr Grażyna Czarkowska**

Name of lecturer:**mgr Grażyna Czarkowska**

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 2 |
| **Laboratory** | 30 | 2 | I | Grade | |

**COURSE AIM:**

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help students to develop their ability to apply language functions to effective communication in everyday life. The course also aims to further develop students' ability to use the language of astronomy in order to discuss problems concerning astronomy and read, with understanding, specialist texts. It also encourages students to master their skills of expressing present and past and form questions to get all kinds of information. It provides an opportunity to revise the rules and master the skills of giving a presentation in English.

**ENTRY REQUIREMENTS:**

B1+/B2 of the Common European Framework of Reference for Languages specified by the Council of Europe.

**COURSE CONTENTS:**

During the course students will learn to or improve their ability to:

- describe present and past events using different grammar tenses (4 hours)
- understand non-specialist texts (4 hours)
- understand long dialogues from everyday life situations (2 hours)
- form questions in English – question words and auxiliary verbs (2 hours)
- exchange information about astronomy – how stars are formed, types of stars (2 hours)
- use the language of astronomy in speakig and writing (4 hours)
- understand specialist texts in astronomy – Solar System, star types (4 hours)
- prepare and deliver a presentation on a topic concerning astronomy (4 hours)
- discuss problems concerning astronomy in class, give arguments for and against (4 hours)

## TEACHING METHODS:

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, oral and written exercises.

## LEARNING OUTCOMES:

Depening language skills and competence on level B2 of the Common European Framework of Reference for Languages.

Upon successful completion of the course, the students:

- are able to describe and compare past events using different grammar tenses
- can form questions to get different kind of information
- exchange information on topics in astronomy
- understand specialist texts about star formation, internal structure and types of stars
- know and can present star classification (Main Sequence Stars, Guant Stars, Dwarf Stars, Neutron Stars, Pulsars, Luminosity Classes)
- prepare and deliver a presentation on a chosen topic in astronomy

## LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Classes – grade: a condition for receiving a credit are positive marks for tests, participating in class discussions, dialogues, delivering a presentation in English, getting information on different topics.

## STUDENT WORKLOAD:

Contact time:

- classes – 30 hours
- consultation – 5 hours

Private study – 25 hours

## RECOMMENDED READING:

1. C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007
2. C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University Press 2007

## OPTIONAL READING:

1. V. Evans, *FCE Use of English* , Express Publishing 1998
2. Internet articles
3. S. Hawking, *A Brief History of Time, The Universe In a Nutshell*, Bantam Books 2001

## REMARKS:

[ Kliknij i wpisz inne istotne informacje, które nie znalazły się wyżej ]

# ENGLISH AS A FOREIGN LANGUAGE

# ASTRONOMY

Course code:**09.0-WFiA-AST-JA**

Type of course:**compulsory**

Language of instruction:**english/polish**

Director of studies:**mgr Grażyna Czarkowska**

Name of lecturer:**mgr Grażyna Czarkowska**

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| **Full-time studies** | | | | | 2 |
| **Laboratory** | 30 | 2 | II | Grade | |

**COURSE AIM:**

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help students to develop their ability to apply language functions to effective communication in everyday life. It also encourages students to master their skills of expressing ideas using complex language structures, e.g. Passive Voice, and grammar tenses to describe present, past and future activities. It provides an opportunity to revise the rules and master the skills of giving a presentation in English.

The course also aims to further develop students' ability to use the language of astronomy in order to discuss problems and read, with understanding, specialist texts. The course introduces terminology used to form a definition and give a description of galaxies, comets, interstellar matter.

**ENTRY REQUIREMENTS:**

B1+/B2 of the Common European Framework of Reference for Languages specified by the Council of Europe.

**COURSE CONTENTS:**

During the course students will learn to or improve their ability to:

- describe present, past and future events using different grammar tenses (4 hours)
- understand and use Passive Voice, especially in texts discussing astronomy (4 hours)
- understand long and difficult non-specialist texts describing past, present and future (4 hours)
- exchange information concerning topics in astronomy – galaxies, comets, cosmolgy (4 hours)
- give definitions of interstellar medium, galaxies (2 hours)
- prepare and deliver a presentation on a chosen topic in astronomy (4 hours)

- have discussions using specialist terminology (4 hours)
- understand long dialogues discussing everyday life situations (4 hours)

**TEACHING METHODS:**

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, oral and written exercises.

**LEARNING OUTCOMES:**

Depening language skills and competence on level B2 of the Common European Framework of Reference for Languages.

Upon successful completion of the course, the students:

- are able to describe and compare past,present and future events using different grammar tenses
- understand and form Pasive Voice sentences, especially in scientific context
- can form questions to get information about galaxies, comets and other notions discussed in astronomy
- exchange information concerning astronomy
- find information about new discoveries in astronomy
- understand texts discussing galaxies, comets and interstellar medium
- can give a description of galaxies (types and structure), comets
- can discuss main issues of cosmology
- are able to prepare and deliver a presentation on a chosen topic in astronomy

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Classes – grade: a condition for receiving a credit are positive marks for tests, participating in class discussions, dialogues, delivering a presentation in English, getting information on different topics.

**STUDENT WORKLOAD:**

Contact time:

- classes – 30 hours
- consultation – 5 hours

Private study – 25 hours

**RECOMMENDED READING:**

1. C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007
2. C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University Press 2007
3. 

**OPTIONAL READING:**

1. V. Evans, *FCE Use of English* , Express Publishing 1998
2. Internet articles
3. S. Hawking, *A Brief History of Time, The Universe In a Nutshell*, Bantam Books 2001
4. V. Evans, *Grammarway*, Express Publishing 2006

**REMARKS:**

[ Kliknij i wpisz inne istotne informacje, które nie znalazły się wyżej ]

# ENGLISH AS A FOREIGN LANGUAGE

# ASTRONOMY

Course code:**09.0-WFiA-AST-JA**

Type of course:**compulsory**

Language of instruction:**english/polish**

Director of studies:**mgr Grażyna Czarkowska**

Name of lecturer:**mgr Grażyna Czarkowska**

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| **Full-time studies** | | | | | 1 |
| **Laboratory** | 30 | 2 | III | Grade | |

**COURSE AIM:**

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help the students to improve their ability to apply language functions to effective communication in everyday life. The course also aims to improve students' ability to describe hypothetical situations and use Passive Voice properly. The course revises grammar structures used to describe past, present and future activities. It focuses on improving students' ability to use specialist vocabulary in speaking and enables students to further develop specialist terminology (atom, standard model) and abiliy to discuss problems and form questions.

**ENTRY REQUIREMENTS:**

B1+/B2 of the Common European Framework of Reference for Languages specified by the Council of Europe.

**COURSE CONTENTS:**

During the course students will learn to or improve their ability to:

- describe past eventsusing different grammar structures (4 hours)
- understand and use in practice structures describing future events (4 hours)
- understand and use Passive Voice (2 hours)
- use conditional sentences to describe hypothetical situations in present and past (4 hours)
- understand and use relative clauses (2 hours)
- exchange information about astronomy (2 hours)
- understand and analyse specialist texts (4 hours)
- prepare and deliver a presentation on a topic concerning astronomy (4 hours)
- present latest discoveries in astronomy (2 hours)

- form questions about problems in astronomy (2 hours)

### TEACHING METHODS:

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, listening, oral and written exercises.

### LEARNING OUTCOMES:

Depening language skills and competence on level B2 of the Common European Framework of Reference for Languages.

Upon successful completion of the course, the students:

- are able to describe and compare past, present and future events using different grammar tenses
- understand and form sentences in Passive Voice used in specialist texts
- can form relative clauses and know how to use relative pronouns
- understand specialist texts on atoms and elementary particles
- know how to form questions concerning problems and issues in astronomy
- can prepare and give a presentation on a topic concerning astronomy
- can present problems discussed in specialist texts
- can cooperate with members of a group, exchange information, and discuss problems
- understand the need for lifelong education

### LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Classes – grade: a condition for receiving a credit are positive marks for tests, participating in class discussions, dialogues, delivering a presentation in English, getting information on different topics.

### STUDENT WORKLOAD:

Contact time:

- classes – 30 hours
- consultation – 5 hours

Private study – 25 hours

### RECOMMENDED READING:

1. C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007
2. C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University Press 2007

### OPTIONAL READING:

1. *FCE Use of English* by V. Evans
2. Internet articles
3. R. Murphy *English Grammar in Use*.
4. S. Hawking, *A Brief History of Time, The Universe In a Nutshell*, Bantam Books 2001

### REMARKS:

[ Kliknij i wpisz inne istotne informacje, które nie znalazły się wyżej ]

# THEORETICAL PHYSICS

Course code:**13.2-WFiA-AST-FTEO**

Type of course:**compulsory**

Language of instruction:**english/polish**

Director of studies:**prof. dr hab. Piotr Rozmej**

Name of lecturer: **Lecture – prof. dr hab. Piotr Rozmej**
**Class – prof. dr hab. Piotr Rozmej**

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | |
| **Lecture** | 30 | 2 | IISD | Exam | 3 |
| **Class** | 30 | 3 | | Grade | 4 |

## AIMS OF THE COURSE

To teach the student advanced methods of quantum mechanics,. To teach approximation methods and give foundations for relativisitc quantum mechanics.

## ENTRANCE REQUIREMENTS

Knowledge of first course of quantum mechanics

## COURSE PROGRAMME

**LECTURE:**

1. Postulates of quantum mechanics – recollection.
2. Approximate methods:
   - Perturbation theory (time independent). Non-degenerate case. Interpretation of Stern-Gerlach effect and Zeeman effect. Degenerate case. Stark effect.
   - Variational principle and variational method. Many-body problem of interacting particles. Mean field approach, self-consistent method.
3. Symmetries and conservation laws:
   1) Unitary transforamtions. General formutarion.
   2) Translations and conservation of momentum.
   3) Rotations and conservation of angular momentum.
   4) Translations in time and conservation of energy.
   5) Space inversion and parity conservation.
4. Second quantization, occupation number representation. Creation and anihilation operators for fermions.
5. Occupation number representation. Creation and anihilation operators for bosons.
6. Elements of relativistic quantum mechanics:

- Klein-Gordon equation.
- Dirac equation.
- Free electron motion in Dirac theory. Negative energy states.
- Magnetic moment of electron.
- Spin.
- Hydrogen atom in Dirac theory.

7. Universal properties of wave packet dynamics in bounded systems.
8. Fermi and Bose statistics..

**CLASS:**

Essentially the same topics, but with extension of particular calculations and interpretations on several examples.

**TEACHING METHODOLOGY:**

Lectures on problems and discussions. Oral practice, in which students solve tasks.

**LEARNING OUTCOMES:**

Student derives conclusions from particular postulates of quantum mechanics (K2A_W02). Applies several approximate methods(K2A_W03).

Is familiar with different representations of physical operators (K2A_W04)..

Student is able to link symmetries of the quantum system with particular conservation laws (K2A_U06)..

Is aware of relativistic effects (like spin of fermions) present in quantum systems (K2A_W06).

**ASSESSMENT CRITERIA:**

**LECTURE:** A course credit for the lectures is obtained by taking a final exam composed of tasks of varying degrees of difficulty.

**CLASS:** During the classes the preparation of the students will be checked as well as their understanding of the lecture content at the time of the lectures.

To obtain a course credit for the exercises 50% of the maximum number of points will be required, which can be achieved through two cumulative tests. A student who achieves at least 10% of the maximum points and who does not exceed the class absence limit has the right to a resit test of the entire material before the examination date. The result of the exam is also affected by class participation and preparation for the class.

Entrance to the exam requires prior accreditation of the course exercises.

**STUDENT WORKLOAD:**

Contact hours:

- lectures: 30 hours
- exercises: 45 hours
- consultation: 10 hours

Total: 85 hours

Individual workload of student:

- preparation for lectures: 20 hours
- preparation for exercises: 30 hours
- preparation for tests: 20 hours
- preparation for exam 10 hours

Total: 85 hours

Total: 165 hours, 8 ECTS

**Final total: 120 hours, 5 ECTS points.**

**RECOMMENDED READING:**

1. P. Rozmej, *Lecture,* pdf file, delivered to students.
2. St. Szpikowski, *Elementy mechaniki kwantowe*j, Wyd. UMCS, 1999.

**OPTIONAL READING:**

1. I. Białynicki-Birula, M. Cieplak, J. Kamiński, *Theory of quanta,* Warszawa, PWN, 2001
2. A.L. Schiff, *Quantum mechanics,* PWN, Warszawa 1987

**REMARKS:**

# CELESTIAL MECHANICS MECHANIKA NIEBA

Course code: 13.7-WFiA-AST-MNIE

Type of course: compulsory

Language of instruction: english/polish

Director of studies: Prof. dr hab. A.J. Maciejewski

Name of lecturer: Prof. dr hab. A.J. Maciejewski

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 10 |
| Lacture | 30 | 2 | I, II | Exam | |
| Class | 30 | 2 | | Grade | |

**COURSE AIM:**

Expanding knowledge of celestial mechanics and complementing it with nesessary topics from theoretical mechanics.

**ENTRY REQUIREMENTS:**

Knowledge of general astronomy, fundamental physics and introduction to celestial mechanics. Mathematical analysis and algebra in range of studies' program.

**COURSE CONTENTS:**

1. Differential equations and conservation laws.
2. The dynamics of systems with one degree of freedom and movement in the central fields.
3. Two body problem.
4. The Lagrange formalism.
5. Hamiltonian mechanics.
6. Canonical transformation and perturbations calculus.
7. Perturbed keplerian motion.
8. Relativistic effects in orbital motion.
9. Three body problem.
10. Introduction to N-body problem.
11. Restricted three body problem.
12. Stability of libration points.
13. Rigid body dynamics.
14. Numerical methods of mechanics.
15. Introduction to deterministic chaos.

**TEACHING METHODS:**

Conventional lecture, analytical and numerical calculations.

## LEARNING OUTCOMES:

Students can employ first integrals to study the equations of motion. Can effectively solve the equations of motion. Students are able to describe and understand the Lagrange formalism.

In particular, they can determine the functions and Lagrange equations for problems of celestial mechanics. They know and are able to apply Noether's theorem. They know, and can apply Hamiltonian formalism for description of mechanical systems. They can also use the canonical transformation. They know the basics of perturbation theory and are able to apply it to the study of the disturbed Kepler disturbed system. In particular, they can determine the precession of perycenters caused by the flattening of the central body and relativistic effects.

Student knows the basic facts about the dynamics of N body problem. Can describe Euler and Lagrange solutions of unrestricted three body problem. Can examine the stability of the equilibria positions of Hamiltonian systems.

Student knows the elements of rigid body dynamics and can use them to describe the rotational movements of celestial bodies.

Student is able to make effective use of numerical methods to the study of movement of bodies. In particular can integrate numerically differential equations using different numerical methods to model the motion of the planets and other bodies in the planetary system.

The student knows and understands the concept of deterministic chaos and its importance in the study of evolution of celestial bodies' motions.

The student knows the methods of modern mechanics and using them can describe, model and study the motion of mechanical systems. **(K_W02, K_W03, K_W05, K_W08)**

Students can carry, Basing on the knowledge of the laws of physics, calculations to solve problems and issues related to the orbital and rotational motion of bodies. **(K_U09).**

## LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture: The course credit is obtained by passing 2 written and oral final exams;

Class: Written test. A student is required to obtain at least the lowest passing grade from the test organized during class.

## STUDENT WORKLOAD:

**- participation in lectures: 30 weeks x 2 hours = 60 hours**

**- participation in classes: 30 x 2 = 60 hours**

- preparation for classes 30 x  2 = 60 **hours**

- finishing computational tasks at home 30 x 1 = 30 **hours**

**- attending lecturers' office hours = 15 hours**

- preparation for exam = 20 **hours**

**- udział w egzaminie = 6 hours**

TOTAL: 251 **hours**

## RECOMMENDED READING:


1. Florian Scheck, Mechanics,  Springer, 2007
2. H. Pollard, Mathematical Introduction to Celestial Mechanics, Prentice Hall, 1966
3. Morbidelli, Modern Celestal Mechanics, Taylor & Francis, 2002


## OPTIONAL READING:


1. J. V. Jose,  E. J. Saletan, CLASSICAL DYNAMICS:A CONTEMPORARY APPROACH; Univ. Cambridge, 1998

# ASTROPHYSICS I

Course code:13.7-WFiA-AST-ASF1

Type of course:**obligatory**

Language of instruction:**english/polish**

Director of studies:**dr Wojciech Lewandowski**

Name of lecturer:**dr Wojciech Lewandowski**

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| **Full-time studies** | | | | | 15 |
| **Lecture** | 75 | 5 | I | Exam | |
| **Class** | 105 | 7 | | Grade | |

**COURSE AIM:**

An extension of the knowledge about stellar astrophysics, stellar evolution and binary stars evolution, and the final stages of the stellar evolution.

**ENTRY REQUIREMENTS:**

Basic knowledge in the field of astrophysics, namely the structure and evolution of stars. Basic knowledge of celestial mechanics.

**COURSE CONTENTS:**

1. The strucrure of stars. Basic laws governing the stellar structure.
2. Stellar atmospheres. The origin of stellar spectra. The influence of physical properties of a star on the shape of spectral lines.
3. Evolution of stars of various masses. Interstellar clouds, proto-stars, circumstellar disks. Properities of main sequence stars of various mass and chemical composition. Post-main sequence evolution – giants and supergiants. Horizontal branch and asymptotic branch.
4. Final stages of stellar evolution. The basics of degenerated matter physics. White dwarves, neutron stars and black holes. Basic ideas of the General Relativity theory.
5. Binary and multiple stars. Roche surfaces and Lagrange points. The types of binary systems: detached, semi-detached and contact. The evolution of close binary systems. Cataclysmic variables and X-ray binaries.

**TEACHING METHODS:**

Classic lecture. Computational exercises during class plus a project method – an extended study of a selected topic from the lecture area of interest.

**LEARNING OUTCOMES:**

Student can name and explain the basic laws governing teh structure of stars, with the particular focus on the hydrostatic equilibrium. Based on his knowledge of physics and astronomy he can describe the structure of stars of various masses, point out and explain the reasons behind the differences. Studen can explain the origin of the stellar spectrum and the influence of various physical properties on the spectral characteristic.

Student has extended knowledge of the stellar evolution. He can describe the structure of a star during various stages of the evolution, based on the star's and chemical composition. He can explain the process of stellar formation. He is able to point out and explain the differences in the evolution of stars of different mass.

Student has extended knowledge of the final stages of stellar evolution: white dwarves, neutron stars and black holes. He is able to explain how these objects properties are the outcome of the previous evolution. He can explain the observational properties of these objects based on their physical parameters.

Student understands the differences between the solitary star avolution and the evolution in a binary system, and is able to explain them. He can describe the mechanics of a binary system, and its influence on the stellar evolution. He can explain how the mass transfer can affect the evolution of the stars in a binary. He can name and describe the standard types of binaries. Based on the current parameters of a binary star he can describe its earlier and future evolution.. **(K_W01, K_W02, K_W04)**

Using the acquired theroetical knowledge student can solve simple analytical problems concerning the stellar evolution and binary stars astrophysics. **(K_U04, K_U05, K_U06)** He can independently study a chosen topic from the field of stellar evolution or binary star astrophysics, using the available literature **(K_U07, K_K01, K_K04, K_K06).** He is able to present the results of his research in a wrirren form **(K_U01).**

## LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture: Oral exam, passing condition – positive grade.

Class: written test – solving computational exercises( passing condition – positive grade), and a positive grade from the written research report.

## STUDENT WORKLOAD:

**- participation in lectures 15 x 3 = 45 h**

**- participation in classes 15 x 4 = 60** h

- preparation for classes 15 x 2 = 30 h
  - homework 15 x 2 = 30 h
  - working on a research project 15 x 2 = 30 h

**- consultations = 15 h**

- exam preparations = 15 h

**- participation in the exam = 5 h**

TOTAL: 230 h

## RECOMMENDED READING:

1. F. Shu, „Galaktyki, gwiazdy, życie", Prószyński i S_ka, 2003
2. M. Kubiak, „Gwiazdy i materia międzygwiazdowa", PWN, 1994

## OPTIONAL READING:

1. J. Mullaney, "Double & Multiple Stars and how to observe them", Springer, 2005
2. R. Kippenhann, A. Weigert, „Stellar structure and evolution", Springer 1996

## REMARKS:

none

# ASTROPHYSICS II

Course code:13.7-WFiA-AST-ASF1

Type of course: compulsory

Language of instruction: english/polish

Director of studies: dr hab. Jarosław Kijak, prof. UZ

Name of lecturer: Lecture: dr hab. Jarosław Kijak, prof. UZ
Class: dr Olaf Maron

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | |
| **Lecture** | 60 | 4 | II | „Exam” | 4 |
| **Class** | 60 | 4 | | „Grade” | 6 |

## COURSE AIM:

Knowledge in the field of astrophysics: galaxies, the population of stars and interstellar matter. Compact objects in astrophysics.

## ENTRY REQUIREMENTS:

Completion of the course – astrophysics I.

## COURSE CONTENTS:

Construction and structure of the galaxy (the Milky Way). Classification of galaxies, their structure and evolution. Populations of stars and their role in the evolution of galaxies. Interstellar matter. Compact objects in astrophysics and their influence on the evolution of galaxies.

## TEACHING METHODS:

Lecture and class

## LEARNING OUTCOMES:

Student can name and discuss the basic properties of galaxies. He can explain populations of stars and their influence on the evolution of galaxies. The student knows the basic properties of interstellar matter and is able to characterize its role in the evolution of galaxies. He can describe types of compact objects and explain their impact on the evolution of galaxies **(K_W01, K_W03, K_W04, K_K01).**

Student can solve research issues in astrophysics. He can interpret astronomical observations and based on them estimate the most important physical parameters of stars, galaxies and interstellar matter **(K_U02, K_U09, K_U11).** . He can use his knowledge to construct a simple astrophysical research projects **(K_U03, K_U10, K_K02).**

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Lecture: Written examination, Positive passing of final exam

Class: Handing in homework exercises, oral presentations and written test. Positive marks of all activities.

**STUDENT WORKLOAD:**

- Participation in lectures 15 weeks x 3 hours = 45 hours
- Participation in class 15 weeks x 4 hours = 60 hours
- Homework exercises 15 x 1.5 = 22.5 hors
- Participation in the consultations = 2 hours
- Preparation for the exam = 18 hours
- Participation in the exam = 3 hours

TOTAL: 210,5 hours

**RECOMMENDED READING:**


1. Oster L., Astronomia współczesna, PWN Warszawa 1986
2. F.H. Shu, Fizyka Wszechświata, Galaktyki, gwiazdy, życie", Prószyński i S_ka, 2003
3. Galaktyki i Budowa Wszechświata, M. Jaroszyński, PWN, 1993
4. Gwiazdy i materia międzygwiazdowa, M. Kubiak, PWN, 1994
5. Astrofizyka relatywistyczna, M.Demiański PWN, Warszawa 1991


**OPTIONAL READING:**


1. Interstellar Matters, G.L. Verschuur, Springer-Verlag, 1989

# ASTROPHYSICS OF COMPACT OBJECTS

Course code:13.7-WFiA-AST-AOZ

Type of course: compulsory

Language of instruction: english/polish

Director of studies:

Name of lecturer: Lecture: dr hab. Dorota Rosińska, prof. UZ
Class: dr hab. Dorota Rosińska, prof. UZ

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | |
| Lecture | 15 | 1 | III, IV | „Exam" | 2 |
| Class | 15 | 1 | | „Grade" | 3 |

**COURSE AIM:**

Deep knowledge in the field of astrophysics of compacts objects

**ENTRY REQUIREMENTS:**

Basic knowledge of properties of compact objects, of quantum physics and of general relativity. Ability to program and use numerical methods

**COURSE CONTENTS:**

1 Equation of state and structure of white dwarfs and neutron stars
2 Non-rotating models of neutron stars
3 Stability of neutron stars and white dwarfs
4 Schwarzschild solution and properties of spherically symmetric black holes.
5 Kerr black holes.
6 Properties of rotating neutron stars
7 Criteria for the stability of rigidly rotating relativistic stars
8 Astrophysics of compact binaries
9 Compact objects as sources of gravitational waves

**TEACHING METHODS:**

Lecture and class

**LEARNING OUTCOMES:**

A student is able to characterize the final stages of stellar evolution: white dwarfs, neutron stars and black holes. Can describe the basic differences between stars and compact objects. A student has knowledge of equations of state of dense matter. Understands and describes the processes occurring in the interior of neutron stars and white dwarfs. Describes the internal structure of dense star depending on the density in their interior.
A student is able to construct numerical models of non-rotating white dwarfs and neutron stars, and understands the reasons for the existence of the upper limit on their gravitational mass. Can describe the effect of rotation (rigid, differential) on the global parameters of neutron stars. Can provide the stability criteria for non-rotating and rotating relativistic stars.
Can name and describe the most important relativistic effects associated with compact objects. Has knowledge of astrophysical phenomena occurring in binary systems containing a compact object. Has a basic knowledge of properties of black holes. Can describe mechanisms of emission of gravitational radiation from compact object binaries, or rotating neutron stars.

Students can write numerical codes (construct algorithms or adopt available numerical libraries) to solve basic problems arising in astrophysics of compact objects. Inn particular to integrate the equations of the stellar structure of relativistic stars (Oppenheimer-Volkoff equations) to obtain their gravitational mass and radius for a given equation of state. (K_W08, K_U05, K_U09, K_U10).

A student understands the need for further training and is able to understand the lectures of specialists in the field of relativistic astrophysics (K_K01, K_U07, K_W05, K_W06). Can analyze astrophysical problems and formulate questions to have deeper understanding of a topic (K_K02, K_U01, K_U02, K_U04). Can use his knowledge to give a lecture or write an article for general public – popularization of science (K_K05, K_K07). Is able to search for information in english literature (K_W10, K_K06).

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Lecture: Written examination, Positive passing of final exam

Class: Handing in homework exercises, oral presentations, passing a written test, writing a program to calculate properties of compact objects. Positive marks of all activities.

**STUDENT WORKLOAD:**

- Participation in lectures 15 weeks x 2 hours = 30 hours
- Participation in class 15 weeks x 2 hours = 30 hours
- Preparation to classes 15 x 2 hours = 30 hours
- Homework exercises 10 x 1 hours = 10 hours
- Participation in the consultations = 10 hours
- Preparation for the exam = 5 hours
- Participation in the exam = 3 hours

TOTAL: 118 hours

**RECOMMENDED READING:**

1. S. Shapiro, S. Teukolsky, „Black Holes, White Dwarfs and Neutron Stars", Wiley-VCH 2004

2. M. Demiański „Astrofizyka relatywistyczna", PWN
3. P. Haensel, A.Y. Potekhin, D.G. Yakovlev „Nutron Stars", Springer 2007
James B. Hartle „Grawitacja", 2009, ISBN 9788323504764

**OPTIONAL READING:**

1. C. W. MISNER,K. S. THORNE, J. A. WHEELER, „GRAVITATION" 1973

## COMPUTER NETWORKS

Course code:11.3-WFiA-AST-SKOM

Type of course:choosable

Language of instruction:english/polish

Director of studies:Krzysztof Krzeszowski

Name of lecturer:Krzysztof Krzeszowski

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | |
| Laboratory | 75 | 5 | 2 | Grade | 6 |

**COURSE AIM:**

Ability to create interactive database applications available on intranets and the Internet.

**ENTRY REQUIREMENTS:**

Ability to program in any high level language.

**COURSE CONTENTS:**

1 1. Django web framework as developed in Python
2. The structure of web applications based on the pattern of MTV
3. Fundamentals of database systems for example, SQLite and PostgreSQL
4. Object-relational mapping
5. Creating models
6. Views
7. The template system
8. Deployment project

**TEACHING METHODS:**

laboratory exercises

**LEARNING OUTCOMES:**

The student understands the concept and principles of the Django web framework. He can distinguish and characterize the individual elements and create Django projects. Student can specify the design layer (Model, Template and View) and understand the differences between them. He knows the rule of relational databases. The student knows how to use the tools with graphical user interface to a database. He knows the principle of ORM in Django. Student can create their own models and combine them using foreign keys or relationships m2m. It can create a diagram of the relationship between design models and provide it with UML diagrams. Students can create a URI patterns and correctly arrange them between applications. He can create custom views based on a set of generic views, he can choose appropriate generic views depending on the function, which is to meet its own view. The student knows the rules for creating templates. The base can create templates and use them to create templates rendered by the views of their own and generic. Student is able to run your project on Apache with WSGI modular. (K_W08, K_U07, K_U10, K_K04)

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

The pass is to create an interactive database application based on Django framework.

**STUDENT WORKLOAD:**

- Participation in the laboratory 15 x 4 = 60 hours.
- Preparation for the laboratory 15 x 4 = 60 hours
- Participation in the consultations = 2 hours

TOTAL: 122 hours

**RECOMMENDED READING:**


1. https://docs.djangoproject.com/

# DIGITAL IMAGES ANALYSIS

Course code:11.3-WFiA-AST-ANOC

Type of course:optional

Language of instruction:english/polish

Director of studies:Dr Krzysztof Maciesiak

Name of lecturer:Dr Krzysztof Maciesiak

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 4 |
| Lecture | 60 | 4 | III | Exam | |

**COURSE AIM:**

Broadening of a knowledge on digital images analysis. Acquiring skills of searching for, and advanced analysis of digital images using professional astronomical tools: IRAF, SExtractor, MaximDL, European Virtual Observatory.

**ENTRY REQUIREMENTS:**

English language at the intermediate level. Basic skills in using computer programmes in the field of data analysis.

**COURSE CONTENTS:**

1. Data acquisition and preliminary analysis (European Virtual Observatory)

   a) acquisition and visualization digital astronomical images – Aladin, DS9

   b) acquisition, analysis and visualization tabular data (catalogues of the astronomical object position, their luminosity, etc.) - TOPCAT, VODesktop

   c) spectral analysis of astronomical objects – SPLAT

2. Advanced analysis of astronomical images

   a) automatic data reduction of digital images to remove unwanted effects (reduction bias, dark, flat) – IRAF (Image Reduction and Analysis Facility), MaximDL, script languages

   b) detection of astronomical objects (stars, galaxies, comets) in digital images – IRAF, SExtrator

   c) astrometric calibration of digital images using WCS coordinates (World Coordinate System) - IRAF, MaximDL, Sextractor, Aladin, DS9

**TEACHING METHODS:**

Lecture combined with a practice classes

**LEARNING OUTCOMES:**

1. Student knows, understands and can describe methods of an analysis of astronomical digital images.
2. Student can use tools of the European Virtual Observatory to acquiring astronomical data (digital images, stars catalogues, spectral data)
3. Student can do basic observational data analysis (**K_U08**).
4. Student can use professional astronomical tools (IRAF, MaximDL, Sextractor, EVO) to perform astrometric and photometric analysis of digital images
5. Student knows advanced computational techniques supporting work of an astronomer, and understand their limitations (**K_W07**).
6. Student can prepare simple research project and observational programmes to solve not complicated astrophysical problems (**K_U03**).

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Practical exam. Pass condition – satisfactory grade

**STUDENT WORKLOAD:**

**- lectures 15 x 4 h = 60 h**

- preparation for lectures 15 x 1 h = 15 h

- work at home 15 x 1 h = 15 h

**- consultations 2 h**

- preparation for exam 6 h

- **exam 2 h**

**TOTAL: 100 h**

**RECOMMENDED READING:**

1. Howell, S.B., Handbook of CCD astronomy, Cambridge University Press, 2006
2. Documentation of the European Virtual Observatory (http://www.euro-vo.org/pub/)
3. Documentation of the IRAF package (http://iraf.noao.edu/tutorials/tutorials.html)
4. Documentation of the SExtractor programme (http://www.astromatic.net/software/sextractor)

**OPTIONAL READING:**

1. Manuals of tools of the European Virtual Observatory (http://cds.u-strasbg.fr/twikiAIDA/bin/view/EuroVOAIDA/VOSchool10/WebHome)
2. Documentation of a chosen scripting language (e.g. http://docs.python.org/tutorial/)

**REMARKS:**

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# RADIATIVE PROCESSES IN ASTROPHYSICS

Course code:13.7-WFiA-AST-PPwA

Type of course:compulsory

Language of instruction:english/polish

Director of studies:Prof. G. Melikidze

Name of lecturer:Prof. G. Melikidze

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 10 |
| Lecture | 60 | 4 | III | Exam | |
| Class | 60 | 4 | | Grade | |

**COURSE AIM:**

The expansion of the knowledge of the theory of generation and propagation of radiation. To transfer messages from astrophysics allowing the students to understand on an advanced level most of the phenomena that involve the formation and evolution of the observed radiation from astronomical objects.

**ENTRY REQUIREMENTS:**

Knowledge of general astronomy, mathematical analysis and the basis of theoretical physics.

**COURSE CONTENTS:**

1. The basic properties of radiation.
2. The radiation flux.
   2.1. Macroscopic description of the radiation transfere.
   2.2. A stream of an isotropic source.
3. The intensity of radiation and its moments.
   3.1. The energy density of radiation.
   3.2. Radiation pressure.
4. The radiation transfer.
5. The thermal radiation.
6. Einstein coefficients.
7. The scattering effects, random walking.
8. The radiation diffusion.
9. The basic theory of radiation field.
   9.1. Polarization and Stokes parameters.
10. Radiation from moving charges.
    10.1.Lienard-Wiecharta potentials.

11. Radiation reaction.
12. Synchrotron radiation.
13. Compton scattering.
14. The plasma effects.

**TEACHING METHODS:**

The conventional lectures, the conventional classes

**LEARNING OUTCOMES:**

Students can describe and discuss the fundamental laws of the radiation transfer, the physical processes responsible for the generation of electromagnetic waves and mutual interaction of waves and matter, with particular emphasis on those that apply to astrophysical issues. The student knows, understands and is able to describe the basic physical laws that govern the generations and propagation of radiation. The student has a basic knowledge on the polarization of electromagnetic waves and the Stokes parameters. He can name and describe the radiative processes occurring in the astronomical objects. (**K_W02, K_W03, K_W05**).

Taking into account their knowledge of the laws of physics, students can solve some the problems and issues of astrophysics. They are able to interpret simple observation of radiation sources and based on them estimate the most important physical parameters: brightness, size, temperature (**K_U01, K_U02**). Students can use their knowledge and understanding of astrophysics to distinguish between the physical characteristics of radiation sources (**K_U04**).

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Lecture: Oral examination; Condition assessment - a positive mark of the exam.

Classes: Written test - positive mark of the test.

**STUDENT WORKLOAD:**

- Attendance of the lectures 15 weeks x 4 hours = 60 hours
- Attendance of the classes 15 x 4 = 60 hours.
- Preparation for the classes 15 x 3 = 45 hours
- Homework 15 x 2 = 30 hours
- Participation in the consultations = 15 hours
- Preparation for the exam = 15 hours
- Participation in the exam = 5 hours

TOTAL: 230 hours

**RECOMMENDED READING:**

1. The lecture notes
2. Radiative processes in astrophysics, (G. Rybicki, A. Lightman) John Wiley @ sons, 1979

**OPTIONAL READING:**

1. Astrophysical formulae, a compedium for the physicist and astrophysicist (K.R. Lang), Springer-Verlag 1980
2. Theoretical Physics and Astrophysics (V.L.Ginzburg) Pergamon Press PRES

**REMARKS:**

# HIGH-ENERGY ASTROPHYSICS

Course code:13.7-WFiA-AST-AWYS

Type of course:compulsory/optional

Language of instruction:english/polish

Director of studies: dr A. Słowikowska

Name of lecturer: dr A. Słowikowska

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | |
| Lecture | 30 | 2 | III | Exam | 3 |

**COURSE AIM:**

Consolidation and expansion of the basic concepts of high-energy astrophysics. Forward the message to enable the understanding of high-energy astrophysical processes.

**ENTRY REQUIREMENTS:**

Knowledge from the introduction to astrophysics, compact objects, Astrophysics I and II.

**COURSE CONTENTS:**

-- Special Theory of Relativity.
-- Physics of fluids.
-- Radial processes.
-- Star supernovae.
-- Neutron stars, pulsars and magnetars.
-- Binary systems of compact objects.
-- Gamma-ray bursts and gamma-ray burst afterglow.
-- Active Galactic Nuclei.

**TEACHING METHODS:**

Lecture with exercises conventional accounting

**LEARNING OUTCOMES:**

The student knows and understands the following: Lorentz transformation, the basis of tensor calculus, space-invariant; collision, the equation of state, Bernoulli equation, the shock wave; properties of the photon spectrum, radiant transfer, blackbody radiation; Observational parameters and classification of supernovae of Type Ia supernovae and II supernova remnants; observational properties of pulsars, pulsars dipole radiation model, equation of state of neutron stars, magnetars; dynamics of binary systems, X-ray binary systems, neutron star binaries; observational properties of gamma-ray bursts, gamma-ray bursts physical model; mechanism of action of active galactic nuclei, universal model of AGN, cosmological significance. (K_W02, K_W05, K_W06).

Student is able to carry out the bills for solving problems and issues high-energy astrophysics. Able to interpret astronomical observations carried out in the X-and gamma of the electromagnetic spectrum, and on this basis to estimate the most important physical parameters such as binary systems with a compact object as one of the ingredients (K_U03, K_U04, K_U06). Able to use their knowledge to construct a simple research projects, as well as to present their knowledge in a popular science. (K_K05, K_K07) He can use the English-language literature. (K_W10, K_K06)

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Lecture: Oral examination, Condition Assessment - a positive evaluation of the test

**STUDENT WORKLOAD:**

- Participation in lectures 15 weeks x 2 hours = 30 hours
- Preparation for the lecture 15 x 1 = 15 hours
- Completion of accounting tasks in the house 15 x 1 = 15 hours
- Participation in the consultations = 2 hours
- To prepare for the exam = 4 hours
- Participation in the exam = 3 hours

TOTAL: 69 hours

**RECOMMENDED READING:**


1. 1. U. Kolb, „Extreme Environment Astrophysics", Cambridge, 2010
2. 2. S. Rossweg, M. Brueggen, „Introduction to High-Energy Astrophysics", Cambridge, 2007
3. 3. M. S. Longair, „High Energy Astrophysics", Cambridge, 2011


**OPTIONAL READING:**


1. M. Camenzind, „Compact objects in astrophysics", Springer, 2007
2. 2. W. H. G. Lewin, M. van der Klis, „Compact Stellar X-ray Sources", Cambridge Uni. Press, 2006
3. 3. F. Shu, „Galaktyki, gwiazdy, życie", Prószyński i S-ka, 2003


**REMARKS:**

None

# RADIO ASTRONOMY LAB

Course code:13.7-WFiA-AST-PRAD

Type of course:**compulsory**

Language of instruction:**english/polish**

Director of studies:**dr Wojciech Lewandowski**

Name of lecturer:**dr Wojciech Lewandowski**

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| **Full-time studies** | | | | | 6 |
| **Laboratory** | 75 | 5 | II | Grade | |

**COURSE AIM:**

Presentation of advanced data analysis methods used in astronomy, with the use of practical examples.

**ENTRY REQUIREMENTS:**

The knowledge of basics of radio astronomy, and the elementary numerical and analytical data analysis methods.

**COURSE CONTENTS:**

The rules of proper data analysis – from „raw data" to scientific publication. Radio-astronomy databases. Numerical data analysis methods. Formulation and presentation of the results.

**TEACHING METHODS:**

laboratory exercises: a project method ćwiczenia - data analysis and the presentation of the results. Working in groups, discussion, working with literature sources.

**LEARNING OUTCOMES:**

Student is able to use the acquired knowledge of mathematics, physics and astronomy to properly analyse radio-astronomical data **(K_U06, K_U08).** He is able to use ready-made software used in astrophysical data analysis **(K_U09)**. He is able to develop computer programs suited for advanced data analysis **(K_U10)**. He is able to work in a group on a common project **(K_K03).** He is able tu use the available literature **(K_K04, K_K06)**. He is able to use sofware designed for the graphical presentation of the results **(K_U09)**. He can describe his results, interpret them and draw proper conclusions **(K_U02, K_U04).** He is able to present the outcome of his research in a written form **(K_U01).**

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Grade – and average of grades from the partial projects realised during the classes.

**STUDENT WORKLOAD:**

**- participation in laboratory classes 15 x 5 = 75 h**

- preparation for classes, working with the literature 15 x 2 = 30 h
- working home on the given research projects 15 x 2 = 30 h

TOTAL: 135 h

**RECOMMENDED READING:**

1. D.J. Gryffiths, „Podstawy Elektrodynamiki", PWN Warszawa, 2001
2. K. Rohlfs, T.L. Wilson, „Tools of Radio Astronomy", Springer, 2006

**OPTIONAL READING:**

1.D. Halliday, R. Resnick, "Fizyka t.2", PWN Warszawa, 2001

2. J.D. Krauss, „Radio Astronomy", Cygnus-Quasar Books, 1986

# MONOGRAPHIC LECTURE 1: GENERAL RELATIVITY THEORY WYKŁAD MONOGRAFICZNY 1: OGÓLNA TEORIA WZGLĘDNOŚCI

Course code: 13.7-WFiA-AST-WMON

Type of course: compulsory

Language of instruction: english/polish

Director of studies: Prof. dr hab. A.J. Maciejewski

Name of lecturer: Prof. dr hab. A.J. Maciejewski

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 3 |
| Lecture | 30 | 2 | III | Exam | |

**COURSE AIM:**

To provide the knowledge necessary to understand the general theory of relativity, which is needed in cosmology.

**ENTRY REQUIREMENTS:**

Mathematical analysis and algebra in the range of studies' program. Classical Electrodynamics and mechanics to the same extent.

**COURSE CONTENTS:**

1. Introduction to tensor calculus.
2. Special relativity theory.
3. Curved spacetime.
4. Geodesics.
5. Gravitation as geometry.
6. The Schwarzschild geometry.

**TEACHING METHODS:**

Conventional lecture.

**LEARNING OUTCOMES:**

Students can use the elements of tensor calculus in practice. Among other things, will be able to determine the curvature tensor and the geodesic equation for selected metrics. Will know and understand the laws of relativistic kinematics and dynamics.

The student learns the basic properties of curved spacetime. Will understand Einstein equation and the properties of one of the most important solutions - Schwarzschild spacetime.

Student familiar with these methods of general relativity will be able to effectively explore the problems of modern cosmology and relativistic physics. **(K_W02, K_W03, K_W05, K_W08 (K_U09).** The knowledge gained will help students to study mathematical branches of the physical sciences and engineering.

### LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture: The course credit is obtained by passing a written and oral final exam.

### STUDENT WORKLOAD:

**- participation in lectures: 15 tygodni x 2 godz = 30 godz**

**- attending lecturers' office hours = 10 godz**

- preparation for exam = 12 godz

**- udział w egzaminie = 3 godz**

RAZEM: 55 godz

### RECOMMENDED READING:


1. J. Hartle, Gravity, Addison Wesley, 2003
2. E. Taylor, J. Wheeler, SPACETIME PHYSICS, Freeman, 1992

# MONOGRAPHIC LECTURE

# PULSARS

Course code:13.7-WFiA-AST-WMON

Type of course: optional

Language of instruction: english/polish

Director of studies: dr hab. Jarosław Kijak, prof. UZ

Name of lecturer: dr hab. Jarosław Kijak, prof. UZ

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| **Full-time studies** | | | | | 3 |
| **Lecture** | 30 | 2 | III / IV | „Exam” (*egzamin*) | |

**COURSE AIM:**

The aim of the course is to introduce students to current research fields in pulsar astrophysics.

**ENTRY REQUIREMENTS:**

Astronomical fundamentals

**COURSE CONTENTS:**

Astrophysics of Neutron Stars: Radio Pulsars, Optical, X-Ray Pulsars, Gamma-Ray Pulsars.

**TEACHING METHODS:**

Lecture

**LEARNING OUTCOMES:**

Student can name and discuss the basic properties of neutron stars. Can name and describe methods for detection of pulsars, and explain the properties of pulsar radiation **(KW_05)**. Student can name and describe the physical laws responsible for electromagnetic radiation of pulsar **(K_W03, K_W06, K_K02, K_K06)**.

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Written examination, Positive passing of final exam

**STUDENT WORKLOAD:**

- Participation in lectures 15 weeks x 2 hours = 30 hours
- Preparation for the lecture 15 x 1 = 15 hours
- Participation in the consultations = 2 hours
- Preparation for the exam = 12 hours
- Participation in the exam = 3 hours

TOTAL: 62 hours

**RECOMMENDED READING:**

1. Handbook of Pulsar Astronomy, D. Lorimer and M. Kramer, Cambridge University Press, 2005 Cambridge

**OPTIONAL READING:**

1. X-ray pulsars: a review, http://arxiv.org/abs/1206.3124
2. Gamma-ray pulsars, *fermi.gsfc.nasa.gov/ssc/library/.../149.02.pdf*
3. Optical pulsations from isolated neutron stars, http://arxiv.org/abs/1111.5535

## MASTER LABORATORY PRACOWNIA MAGISTERSKA

Course code: 13.7-WFiA-AST-PMGR

Type of course: compulsory

Language of instruction: english/polish

Director of studies: Prof. dr hab. A.J. Maciejewski

Name of lecturer: Prof. dr hab. A.J. Maciejewski

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 6 |
| Laboratory | 60 | 2 | III/IV | Grade | |

**COURSE AIM:**

Teach students how to use LaTeX word processor to the composition of Master (MSc) thesis.

Teaching students how to present the results in graphs and tables.

Teaching student to present essential theses of their master thesis in the form of lecture and presentation.

**ENTRY REQUIREMENTS:**

Knowledge of programs used to create computer presentations.

**COURSE CONTENTS:**

1. Presentation of subjects and master theses issues.
2. Bascis of thesis editing in LaTeX.
3. The structure of the thesis, the sequence and content of the chapters.
4. Selection and correct use of the literature.
5. Aesthetics of the thesis, text formatting, editing and binding.
6. Tools for creating computer presentations.
7. Scientific computer graphics.
8. Presentations of master theses.

**TEACHING METHODS:**

Laboratory exercises, seminar.

**LEARNING OUTCOMES:**

Students can prepare the thesis properly editorially. He knows the rules for the selection of literature and its use.

Student is able to independently and efficiently prepare a scientific paper or lecture and present it. Can create popular multimedia presentations popular. **(K_U01, K_K05, K_K06, K_K07).**

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Grading of completed tasks from the composition of the text, the evaluation of the presentation. To get credit a student is required to obtain at least passing grades from tasks and presentation.

**STUDENT WORKLOAD:**

**- participation in laboratory: 30 weeks x 2 hours = 60 hours**

**- attending lecturers' office hours = 15 godz**

- preparation for laboratory = 30 x 2 **hours** = 60 **hours**

RAZEM: 135 godz

**RECOMMENDED READING:**

11

11 A. Diller „LaTeX wiersz po wierszu".

11 W. Macewicz „LaTeX w calej okazałości"

11 L. Lamport „LaTeX. Podręcznik i przewodnik użytkownika."

# GRADUATE SEMINAR

Course code:13.7-WFiA-AST-SMGR

Type of course:Compulsory

Language of instruction:english/polish

Director of studies:Prof. G. Melikidze

Name of lecturer:Prof. G. Melikidze

| Form of instruction | Number of teaching hours per semester | Number of teaching hours per week | Semester | Form of receiving a credit for a course | Number of ECTS credits allocated |
|---|---|---|---|---|---|
| Full-time studies | | | | | 2 |
| **Seminar** | 30 | 2 | VI | Grade | |

**COURSE AIM:**

Investigation and research of a topic for a master's thesis. Preparation for the master exam.

**ENTRY REQUIREMENTS:**

Knowledge of general astronomy, the basis of physics and astrophysics.

**COURSE CONTENTS:**

Investigation and research of topics for master's theses, collecting of literature, the choice of material. Preparation of research and discussing research projects. Discussion on topics of theses. Principles of preparation and presentation of a lecture.

Discussion, support and answering any questions related to the collection of literature required for the MA exam. Recapitulation, and discuss issues related to the subject of the final exam.

Discussion, support and explanation of any questions related to collecting of the literature required for the MA exam. Discussion about the issues related to the subject of the final exam.

**TEACHING METHODS:**

The conventional lectures, presentations and discussions.

**LEARNING OUTCOMES:**

The student has a thorough knowledge of the fundamental fields of astronomy, understands the basics of theoretical physics and significance of the structure of theoretical reasoning (**K_W01, K_W02**).

The student has an ability to express the content of astronomy in speech and in writing, in the texts / speeches addressed to audience on different levels of knowledge of astronomy; has skills and ability to formulate astronomical problems and find ways to resolve them (**K_U01, K_U02**) .

**LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:**

Presentation of talks – a positive mark of the presentation.

**STUDENT WORKLOAD:**

- Attendance of the seminars 15 weeks x 4 hours = 60 hours
- Preparation for the seminars 15 x 2 = 30 hours
- Participation in the consultations = 15 hours

TOTAL: 105 hours

**RECOMMENDED READING:**

Literature is given by the teacher, according to the subject and scope of the seminars.

**OPTIONAL READING:**

**REMARKS:**