

## SYLLABUS

### 1. Information about the study programme

<b>1.1 Institution of higher education</b>	West University of Timisoara
<b>1.2 Faculty</b>	Physics and Mathematics
<b>1.3 Department of</b>	Physics
<b>1.4 Field of study</b>	Physics
<b>1.5 Study cycle</b>	Master
<b>1.6 Study programme</b>	Advanced research methods in physics (ARMP); according to COR: Physicist - 211101; Teacher - 233001; University Professor 231005

### 2. Information about the subject/discipline

<b>2.1 Name</b>	Standard Model <b>ARMP1206</b>						
<b>2.2 Course coordinator</b>	Conf. Dr. Paul Gravila						
<b>2.3 Seminar coordinator</b>	Conf. Dr. Paul Gravila						
<b>2.4 Year of study</b>	I	<b>2.5 Semester</b>	2	<b>2.6 Type of assessment</b>	E <sup>1</sup>	<b>2.7 Type of discipline</b>	Ob

### 3. Total estimated time (hours of teaching per semester)<sup>2</sup>

3.1. Nr. of hours/week	4	In which: 3.2 course	2	3.3. seminar	2
3.4. Total hours in the curriculum	56	In which: 3.5 course	28	3.6. seminar	28
<b>Time distribution:</b>					<b>h</b>
Study based on Instructions, course materials, bibliography and notes					40
Additional documentation library, specialized electronic platforms / field					50
Training seminars / laboratories, homework, essays, portfolios and essays					25
Tutoring					
Examinations <sup>3</sup>					4
Other activities					-
<b>3.7 Total hours of individual study</b>					115
<b>3.8 Total hours per semester<sup>4</sup></b>					175
<b>3.9 Number of credits</b>					7

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

<sup>2</sup> The total number of contact hours and individual study hours will be aligned with the number of credits allocated to the course. One credit corresponds to a total between 25 and 30 hours of teaching activities and individual study.

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

<sup>4</sup> Total hours per semester = total hours in the curriculum + total hours of individual study + hours allocated to examinations.

#### 4. Prerequisites (where applicable)

<b>4.1 of curriculum</b>	
<b>4.2 of skills</b>	

#### 5. Conditions (where applicable)

<b>5.1 for the course</b>	Projector, board
<b>5.2 for the seminar</b>	PC room, projector, board

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

<b>Knowledge</b>	Understanding the fundamental concepts of the actual Standard Model of the structure of Matter.
<b>Skills</b>	Understanding methods used in High Energy Physics.
<b>Responsibility and autonomy</b>	Scientific discernment.

#### 7. Contents

The platform through which the course materials in electronic format and other learning/bibliographic resources can be accessed: presentations to be distributed for study; links.

<b>7.1. Course</b>		Teaching methods: Discussions, Board, projector.
1.	What is a Standard Model? How the standard model has evolved from antiquity to the present.	
2.	Dimensions scale.	
3.	A brief history of the discovery of elementary particles.	
4.	Standard Model I. Particles of Matter – fermions.	
5.	Standard Model II. Fundamental Forces – bosons.	
6.	Interactions. Exchange particles.	
7.	QED Feynman Diagrams.	
8.	Mesons and Baryons.	
9.	Quantum numbers. The concept of Isospin.	
10.	Feynman diagrams for the weak interaction. Disintegrations.	
11.	Heavy quarks.	
12.	Discrete symmetries. CPT Theorem. Parity violation.	
13.	The K-mesons and the CP violation experiment.	
14.	Beyond the Standard Model.	
<b>7.2. Seminar:</b>		
1.	Discuss the issues taught at the course (permanent).	

2.	History of particle detectors. The cloud and the bubble chamber.
3.	Calculating a Pion decay event using the Onscreen PP. bubble chamber simulator software. *
4.	Discovery of the top quark at Fermilab.
5.	Feynman diagram computations (use of AI)
6.	Physics at CERN I. Detecting particles. LHC. The ATLAS detector.
7.	Physics at CERN II. Online and offline computing system. The two-level trigger.
8.	Physics at CERN III. Antimatter Factory and Experiments.
9.	Physics at CERN IV. Visualizing events using Minerva.* Higgs events. W- and Z- path.* * computer lab.

### Bibliography

1. The Standard Model in a Nutshell, Dave Goldberg, Princeton University Press (2017).
2. Introduction to Elementary Particles, David Griffiths, Wiley-VCH (2010).
3. Review of Particle Physics, Particle Data Group, <http://pdg.lbl.gov>
4. C. Quigg, Gauge Theories of the Weak, Strong and Electromagnetic Interactions, Benjamin/Cummings Publ. USA (1983).
5. G. Musiol et al, Kern- und Elementarteilchenphysik, Verl. Harri Deutsch (1995).
6. Quang, H. K., Pham, X. Y., Elementary Particles and Their Interactions, Springer Verl. (1998).
7. S. L. Lloyd, Elementary Particle Physics Course PHY653, University of London, UK (1999).
8. Cheng, Li, Gauge theory of elementary particle physics, Oxford Scientific Publ. (1984).
9. B. Povh et al, Particles and Nuclei, Springer Verl. (1999).
10. [www.cern.ch](http://www.cern.ch) (online resources)
11. CERN Minerva software package, sample data and documentation.
12. Communication and sharing of course material using institutional email and/or elearning.

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

Ability to approach working in an international research group; Outreach;

### 9. Use of tools based on generative artificial intelligence

During the semester, students will not be required to write papers and assignments that could be generated with AI. During laboratory and course activities, the teacher will use Internet resources (abundant for this discipline), including AI. There is a seminar activity specifically designed to use AI. Students will be advised on the use of this tool, with an emphasis on asking the question correctly and verifying the answer. During the examination, students will not have access to Internet resources.

### 10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of the final mark
10.4 Course	Subject matter expertise	Multiple choice test (grid)	
10.5 Seminar	Subject matter expertise and presence	Activity	
<b>10.6 Minimum performance standards 50% overall.</b>			

**Date of submission: 27.01.2026**

**Titular of the course:** Conf. Dr. Paul Gravila

Signature:

**Date of approval in department:**

**Seminary titular:** Conf. Dr. Paul Gravila

Signature:

**HEAD OF THE DEPARTMENT:** Conf. Dr. Nicoleta Stefu