Anexa nr. 2

SUBJECT CONTENT

1. Informations about program

1.1 Institution	West University of Timisoara
1.2 Faculty	Faculty of Physics
1.3 Department	Physics Department
1.4 Domain for university master studies	Exact science
1.5 Level of study	Master
1.6 Study directions	Astrophysics, elementary particles and computational physics

2. Informations about discipline

2.1 Subject matter			Quantum fields				
2.2 Course			Lect. dr. Cosmin Crucean				
2.3 Seminar			Lect. dr. Cosmin Crucean				
2.4 Discipline code			**AP1203**				
2.5 Year of study	II	2.6 Semester	I	2.7 Type of evaluation	E	2.8 Subject category	Ob

3. The total estimated time (hours of teaching activities on semester)

3.1 Number of teaching hours on week	2	from which course	2	seminar	1	laboratory	
3.2. Number of hours on semester	56	from which course	28	seminar	28	laboratory	
3.3.Time distribution:							**ore**
Study of course notes,tutorials, bibliography and other notes							40
Supplementary study in library, on media etc.							30
Preparation of seminars / laboratory, homework, reports, portofolio and essay							30
Tutoring							
Exams							4
Other activities……							
3.4 Total hours of individual study	**104**						
3.5 Total hours on semester [1]	**160**						
3.6 Credits	**6**						

4. Preconditions (where appropriate)

4.1 of curriculum	•
4.2 of competences	•

1 Numărul total de ore nu trebuie să depăşească valoarea (Număr credite) x 27 ore

5. Condition (where appropriate)

5.1of the course	
5.2 of the seminars	
5.3 of the laboratory	

6. Specific competences

Professional competences	• Basic knowledge (fundamental concepts of quantum field theory) . • Deep understanding (of basic notions, of physical) . • Physical interpretation of the calculations results and their applications. • Capacity of analyze and synthesize (realization of synthesis and comparisons). • Capacity to plan and organize theoretical applications . • Bibliography investigation . • Knowledge of foreign languages (English) .
Transversal competences	• effective use ofinformation sourcesand trainingassistance(Internet portals, specializedsoftware, data bases, online courses, etc..) bothinromanian andin a foreign language (english)

7. Objectives (reieşind din grila competenţelor specifice acumulate)

7.1 Main objectiv	• Acquiring basic knowledge about quantum field theory • Understanding of the fundamental principles of the theory of free fields
7.2 Specific objectives	• Basic notions needed to construct the theory of free fields • Developing the skills needed to solve problems

8. Table of contents

8.1 Course	**Teaching methods**	**Observations**
1. Representations of the Lorentz group	Interacting teaching using the blackbord	3 hours
2. Representations of the Poincare group; mass and the spin as Poincare invariants	Interacting teaching using the blackbord	3 hours
3. Lagrangeean field theories; Noether theorem	Interacting teaching using the blackbord	2 hours
4.The principle of the second quantization. Construction of the Fock space,creation and annihilation operators	Interacting teaching using the blackbord	2 hours
5. Field operators	Interacting teaching using the blackbord	2 hours
6. Free Klein-Gordon field	Interacting teaching using the blackbord	2 hours
7. The quantization of free Klein-Gordon field	Interacting teaching using the blackbord	2 hours
8. The free Proca field; Proca equation and the conserved quantities	Interacting teaching using the blackbord	2 hours

9. Free electromagnetic field	Interacting teaching using the blackbord	2 hours
10. The quantization of the electromagnetic field in the Coulomb gauge	Interacting teaching using the blackbord	2 hours
11. The free Dirac field; The Dirac equation	Interacting teaching using the blackbord	2 hours
12. The quantization of the Dirac field	Interacting teaching using the blackbord	2 hours
13. The Dirac field with zero mass	Interacting teaching using the blackbord	2 hours

References

1.J. D. Bjorken and S. D. Drell, Relativistic Quantum Fields, (Mc Grew Hill, New York, 1965)

2. S. Weinberg, The Quantum Theory of Fields, (Cambridge Univ. Press,Cambridge 1995)

3. G. W. Mackey, induced Representation of groups and Quantum Mechanics,Benjamin, New York, 1968)

4. B. Thaller, The Dirac Equation (Springer Verlag, Berlin Heidelberg, 1992).

5. V. Novacu, Teoria cuántica a campurilor (Editura Tehnica , Bucuresti 1984)

8.2 Seminar	**Teaching methods**	**Observations**
1. Time evolution of the quantum systems	Interacting teaching using the blackbord	2 hours
2. Temporal evolution pictures. Heisenberg picture and the interaction picture	Interacting teaching using the blackbord	2 hours
3. Second quantization for femions and bosons.	Interacting teaching using the blackbord	2 hours
4. Conserved quantities for the electromagnetic field	Interacting teaching using the blackbord	2 hours
5. Conserved quantities for the Klein-Gordon field	Interacting teaching using the blackbord	2 hours
6. Conserved quantities for the Dirac field	Interacting teaching using the blackbord	2 hours
7. Polarization vectors for the Proca field and photon field	Interacting teaching using the blackbord	2 hours
8. The method of Green functions	Interacting teaching using the blackbord	2 hours
9. The Green functions for the Klein-Gordon field	Interacting teaching using the blackbord	2 hours
10. The Green functions for the electromagnetic field	Interacting teaching using the blackbord	2 hours
11. Properties of the Dirac spinors	Interacting teaching using the blackbord	2 hours
12. Spinors in the spin basis and helicity basis	Interacting teaching using the blackbord	2 hours
13. Propagators for the Proca and Dirac fields	Interacting teaching using the blackbord	4 hours
8.3 Laboratory	**Teaching methods**	**Observations**

References

1.J. D. Bjorken and S. D. Drell, Relativistic Quantum Fields, (Mc Grew Hill, New York, 1965)

2. S. Weinberg, The Quantum Theory of Fields, (Cambridge Univ. Press,Cambridge 1995)

3. G. W. Mackey, induced Representation of groups and Quantum Mechanics,Benjamin, New York, 1968)

4. B. Thaller, The Dirac Equation (Springer Verlag, Berlin Heidelberg, 1992).

5. V. Novacu, Teoria cuántica a campurilor (Editura Tehnica , Bucuresti 1984)

9. Evaluation

Activity	Evaluation criteria	Evaluation methods	Percentage of final mark
9.1 Course	final evaluation	written	50% with the observation that 25% is the evaluation during the semester
9.2 Seminar	Problems , homework	written	50% with the observation that 25% is the evaluation during the semester
9.3 Laboratory			
9.4 Minimum performnce standards			
correct formulation of the proposed subject without demonstrations			

Data completării: 31.01.2022

Semnatura titularului de curs:

Lect.dr. Cosmin CRUCEAN

[redacted]

Semnătura titularului de seminar :

Lect.dr. Cosmin CRUCEAN

[redacted]

Semnătura director departament:

Conf.dr. Catalin MARIN

[redacted]