COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2023-2024*

ACADEMIC SUBJECT *Neutrino Physics*

General information	
Year of the course	2nd
Academic calendar (starting and ending date)	1st semester: September - December 2023
Credits (CFU/ECTS):	3
SSD	FIS/04
Language	English
Mode of attendance	Recommended, not compulsory

Professor/ Lecturer	
Name and Surname	Marilisa De Serio, Lorenzo Magaletti
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Telephone	080-5443182, 080-5443225
Department and address	Dipartimento Interateneo di Fisica “M. Merlin”, via Amendola 173 – 70125 Bari
Virtual room	Microsoft Teams
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Prof. Magaletti: Every Tuesday from 3 to 5 p.m. in person by appointment Prof. De Serio: students are invited to send an e-mail to arrange individual or group meetings.

Work schedule			
Hours			
Total	Lectures	Hands-on (laboratory, workshops, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
75	16	15	44
CFU/ECTS			
3	2	1	

Learning Objectives	*The course is intended to provide fundamentals of neutrino physics with special emphasis on neutrino phenomenology and experiments.*
Course prerequisites	*Basic knowledge of quantum mechanics and particle physics*

Teaching strategies	*Class lectures (with slides) and data analysis laboratory*
Expected learning outcomes in terms of	
Knowledge and understanding on:	o Knowledge and understanding of neutrino basic properties and interactions. o Knowledge and understanding of the experimental methods for neutrino detection. o Knowledge of the state of the art of neutrino physics.
Applying knowledge and understanding on:	o Ability to apply neutrino theoretical models to infer and describe the fundamental properties of neutrinos. o Ability to analyse neutrino data using common High Energy Physics tools.
Soft skills	• *Making informed judgments and choices* o Ability to use a critical approach in discussing results from neutrino experiments. o Ability to interpret experimental results in the framework of neutrino theoretical models.

	● *Communicating knowledge and understanding* o Ability to use appropriate scientific language. ● *Capacities to continue learning* o Ability to consult bibliographic material. o Ability to elaborate on and make connections between concepts.
Syllabus	
Content knowledge	2 CFU The course is intended to introduce the basic concepts of neutrino physics providing the theoretical background to understand experimental developments in the field: - Neutrino properties. - Neutrino cross sections. Neutrino sources and detection methods. - Neutrino beams. - Neutrino Monte Carlo generators. - Phenomenology of neutrino oscillations: oscillations in vacuum, oscillations in matter, MSW effect. Current experimental overview. - Neutrino mass and nature: evidence and implications. Sterile neutrinos. - Open questions in neutrino physics: what's next 1CFU Exercises on neutrino physics and laboratory activities.
Texts and readings	*C. Giunti and C. W. Kim,* ***Fundamentals of Neutrino Physics and Astrophysics*** *(Oxford University Press, USA, 2007)* *F. Halzen and A. D. Martin,* ***Quarks and Leptons*** *(John Wiley & Sons, New York, 1984)*
Notes, additional materials	*Additional material on specific topics provided during the course.*
Repository	*Repository on Microsoft Teams dedicated channel.*

Assessment	
Assessment methods	*Oral exam*
Assessment criteria	● *Knowledge and understanding* The student: o has an adequate knowledge and understanding of neutrino properties and interactions, as well as of neutrino oscillation phenomenology in vacuum and in matter; o has an adequate knowledge of neutrino detection techniques related to different neutrino sources and energy ranges; o has an adequate knowledge of the most relevant theoretical models related to the origin of neutrino mass. ● *Applying knowledge and understanding* The student: o is able to apply theoretical models to describe neutrino properties as inferred from experimental results. ● *Autonomy of judgment* The student: o is able to critically analyse the results of the most relevant neutrino experiments in the framework of neutrino theoretical models. ● *Communicating knowledge and understanding* The student: o is able to discuss theoretical models and experimental results with competence, is able to communicate effectively using adequate scientific language. ● *Capacities to continue learning*

	The student: o is able to consult scientific literature; o is able to elaborate on and make connections between concepts; o is able to understand and discuss the latest theoretical and experimental developments.
Final exam and grading criteria	The final grade is expressed on a 30-point scale. The minimum passing grade is 18/30, the maximum grade is 30/30 cum laude. The exam consists in general questions on the main topics discussed during the course. The student will pass the exam if he/she demonstrates adequate understanding of the most relevant neutrino theoretical models and experimental results and is able to effectively communicate using appropriate scientific language. The final grade will depend on the critical ability and competence demonstrated by the student.
Further information	
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