COURSE OF STUDY *Physics (LM-17)*

ACADEMIC YEAR *2023-2024*

ACADEMIC SUBJECT *Nuclear Fusion Technologies*

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	Compulsory

Professor/ Lecturer	
Name and Surname	Nicola Colonna
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Telephone	3494659987
Department and address	Physics Department, room R41
Virtual room	To be announced
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Friday, 10:00 - 12:00, in room R41

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	To provide a qualitative and quantitative understanding of the physical principles at the basis of controlled nuclear fusion, as well as a basic knowledge of the nuclear technologies involved in the energy production by nuclear fusion. The course will mostly be focused on magnetic confinement, but hints of inertial fusion will also be given. Monographic parts of the course will be devoted to negative ion sources for nuclear fusion heating by neutral beam injections, plasma-wall interaction in the tokamak, and neutron damage in structural materials.
Course prerequisites	Basic knowledge of electromagnetism and Nuclear Physics

Teaching strategie	Teaching with the help of slides and discussion of basic exercises.
Expected learning outcomes in terms of	The course will provide basic knowledge on the development of nuclear fusion reactors for energy production. **- Descrittore di Dublino 2**: Capability to understand and follow the development of future reactors based on nuclear fusion and their use for energy production. - **Descrittore di Dublino 3**: capability to judge which one of the nuclear fusion technologies now being investigated are the most promising, and their implication on the “carbon-free” energy production.

Knowledge and understanding on:	Basic principles on nuclear fusion for energy, and on the confinement of high temperature plasmas
Applying knowledge and understanding on:	Capability to understand and follow the development of future reactors based on nuclear fusion and their use for energy production.
Soft skills	Capability to judge which one of the nuclear fusion technologies now being investigated are the most promising, and their implication on the "carbon-free" energy production. Capability to communicate and eventually to non-experts, the state of the art in the development of nuclear fusion reactors for energy production. Acquisition of basic knowledge (physics principles, mathematical tools, advanced technologies, in particular in superconducting magnets) for the comprehension of further developments in the field of nuclear fusion for energy.
Syllabus	
Content knowledge	1. Basic properties of plasmas for controlled nuclear fusion 2. Magnetic confinement of toroidal plasmas 3. Physics and technology of tokamaks 4. Plasma heating: ohmic heating, wave heating, alpha heating, neutral beam injection 5. Negative ion source for heating by neutral beam injection 6. Neutron damage in structural material of fusion reactors 7. Plasma-wall interaction 8. The ITER and DTT projects 9. Inertial fusion, the NIF project
Texts and readings	J. Wesson: Tokamaks J. Freidberg: Plasma Physics and Fusion Energy E. Morse: Nuclear Fusion
Notes, additional materials	*Review articles*
Repository	*Teacher*

Assessment	
Assessment methods	Oral examination, with questions on all arguments of the course and presentation of a deeper knowledge of a selected argument.
Assessment criteria	Demonstration of acquisition of fundamental knowledge at the basis of the production of energy by nuclear fusion. Clear and proper discussion.
Final exam and grading criteria	The final evaluation is in the thirties. The exam is intended to be passed when the vote is higher than 18. For a higher evaluation the student has to demonstrate autonomy of judgment and capability of discussion and presentation of the arguments of the course. The Laude is granted in case of a high degree of deepening of the arguments.
Further information	
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