Course unit English denomination	Advanced Course on Plasma Physics
Teacher in charge (if defined)	- Lidia Piron; - other lecturers (national and international experts)
Teaching Hours	30h
Number of ECTS credits allocated	5
Course period	November 2025
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	This course provides in depth introduction to the following subjects related to plasma physics: - Magnetic confinement in toroidal fusion devices - Nonlinear MHD theory - MHD instabilities and performance limits - Plasma-wall interactions - Neoclassical and turbulent transport - Heating and current drive physics
Learning goals	The objectives of the Advanced Course on Plasma Physics of the PhD in Fusion Science and Engineering are to provide the knowledge base of magnetic confinement nuclear fusion plasmas. Students enrolled in the PhD in Fusion Science and Engineering have heterogeneous backgrounds, and this course shall develop their competences in plasma physics covering the theoretical, numerical, modeling and experimental fields of plasma physics.
Teaching methods	- Frontal teaching - Seminar lectures with the participation of including national and international experts
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No

Prerequisites (not mandatory)	Basic knowledge of plasma physics (recommended)
Examination methods (in applicable)	Two hours examination via moodle, including: open questions/multiple choice questions/ numerical exercises.
Suggested readings	J Wesson, D J Campbell, Tokamaks, Oxford science publications, 3rd edition, Clarendon Press (2004); J A Bittencourt, Fundamentals of Plasma physics, Springer Science & Business Media (2004)
Additional information	Presentations and lesson materials will be made available in moodle.

Course unit English denomination	Advanced Course on Plasma Control & CODAC
Teacher in charge (if defined)	- Gianmaria De Tommasi, Università degli Studi di Napoli Federico II; - other lecturers (national and international experts)
Teaching Hours	30h
Number of ECTS credits allocated	5
Course period	February 2026
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	This course provides in depth introduction to the following subjects related to both plasma control and data acquisition and control systems for magnetic confiment fusion devices (CODAC): - Fundamentals of control theory - Plasma axisymmetric magnetic modelling & control - Control of MHD instabilities - Plasma scenario design & optimization - Plasma Control System Architecture - Instrumentation & Control (I&C) systems
Learning goals	The course aims at introducing the students to the feedback control theory and to its application to the magnetic control of thermonuclear plasmas. It includes one day fully dedicated to lectures on systems and control theory. The control framework is than used to tackle the main plasma magnetic control problems that arise in magnetically confined thermonuclear fusion experimental devices. Hands-on session using Matlab and Simulink are also envisaged to introduce the students to the model-based design of the basic magnetic control algorithms. The course includes also lectures devoted to the design of plasma scenarios, implementation of real-time control systems, as well as seminars from scientists from the main fusion devices in operation or under design.
Teaching methods	- Frontal teaching - Seminar lectures with the participation of including national and international experts - Hands-on session using Matlab and Simulink

Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	ODE, Laplace transform, Z transform, Fourier analysis, basic knowledge of magneto hydrodynamics
Examination methods (in applicable)	Two hours examination via moodle, including: open questions/multiple choice questions/ numerical exercises.
Suggested readings	**Reference book – Plasma control:** *M. Ariola, A. Pironti,* *Magnetic Control of Tokamak Plasmas* *Springer-Verlag, 2016* **Reference books – Control theory:** *F. M. Callier and C. A. Desoer* *Linear System Theory* *Springer-Verlag, 1991* *G. F. Franklin, J. D. Powell and A. Emami-Naeini* *Feedback Control of Dynamic Systems* *Pearson Prentice Hall, 2008* *S. Skogestad and I. Postlethwaite* *Multivariable Feedback Control - Analysis and Design* *John Wiley and Sons, 2006*
Additional information	Presentations and lesson materials will be made available in moodle.

Course unit English denomination	Advanced Course on Engineering and Technology
Teacher in charge (if defined)	- Emanuele Sartori; - other lecturers (national and international experts)
Teaching Hours	30h
Number of ECTS credits allocated	5
Course period	December 2026
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	This course provides in depth introduction to the following engineering and technology subjects in the field of nuclear fusion: - Power plants and reactor design - Materials for fusion reactors - Design of tokamak components and integration - Plasma Facing Components (PFC) - Superconducting magnets for fusion applications - Heating and current drive technology: Electron Cyclotron Resonance Heating (ECRH), Ion Cyclotron Range of Frequencies (ICRF) and Neutral Beam Injection (NBI) - Ultra-High Vacuum Technology - Tokamak operation and operation with deuterium/tritium
Learning goals	The objectives of the Advanced Course on Engineering and Technology of the PhD in Fusion Science and Engineering are to provide the knowledge base of magnetic confinement nuclear fusion technology. Students enrolled in the PhD in Fusion Science and Engineering have heterogeneous backgrounds, and this course shall develop their competences in applied engineering including materials, design concepts, including numerical, modeling and experimental methodologies. Learning and understanding the main technological challenges of fusion devices is fundamental for researchers active in this field.
Teaching methods	- Frontal teaching - Seminar lectures with the participation of including national and international experts

Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of plasma physics (recommended) Basic knowledge of material properties (recommended)
Examination methods (in applicable)	Two hours examination via moodle, including: open questions/multiple choice questions/ numerical exercises.
Suggested readings	INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamentals of Magnetic Fusion Technology, Non-serial Publications, IAEA, Vienna (2023) *https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1945_web.pdf*
Additional information	Presentations and lesson materials will be made available in moodle.

Università degli Studi di Padova

FUSION SCIENCE AND ENGINEERING

Course unit English denomination	Advanced Course on Fusion Plasma Diagnostics
Teacher in charge (if defined)	- Lidia Piron; - other lecturers (national and international experts)
Teaching Hours	30h
Number of ECTS credits allocated	5
Course period	spring/summer 2027
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	This course provides in depth introduction to the following subjects related to plasma diagnostics: - Electromagnetic Diagnostics (Magnetic measurements, Electrostatic probes) - Non-magnetic diagnostics (Interferometry, Polarimetry, Thomson Scattering, Spectroscopy, Motional Stark effect, Reflectometry, Tomography) - Diagnostics for burning plasmas - Neutron diagnostics - Runaway diagnostics - Imaging diagnostics
Learning goals	The objectives of the Advanced Course on Fusion Plasma Diagnostics of the PhD in Fusion Science and Engineering are to introduce students to the physical processes used to measure the properties of plasmas and to describe the most important measurement techniques. Specific examples of data analysis techniques will also be provided. Students enrolled in the PhD in Fusion Science and Engineering have heterogeneous backgrounds, and this course shall develop their competences, covering: theoretical and modeling aspects, experimental application and data analysis, as well as design practices of magnetically confined fusion plasma diagnostics
Teaching methods	- Frontal teaching - Seminar lectures with the participation of including national and international experts plasma - laboratory activity (if applicable)

Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of plasma physics (recommended)
Examination methods (in applicable)	Two hours examination via moodle, including: open questions/multiple choice questions/ numerical exercises. Laboratory report (if applicable).
Suggested readings	I H Hutchinson, Principles of plasma diagnostics, Cambridge University Press (2002) T Donne, Chapter 7: diagnostics, in “Fundamentals of Magnetic Fusion Technology”, IAEA Non-serial Publications, Vienna (2023)
Additional information	Presentations and lesson materials will be made available in moodle.