Activity	Type of activity	Doctoral credits	Hours of teaching	Verification method	Period	PhD year	Training objectives
Electrification of the chemical industry **Prof.ssa Patricia Benito**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on several electrified routes to decarbonize the chemical industry. Then, the focus will be on power-to-heat processes, and on the challenges for their development. In particular, the relationship between heating and reaction media and catalyst properties (e.g. composition, structure, and shaping) will be shown. This will be the basis for the involvement of the students in an active role.
Advanced methods for micro- and nano-fabrication of devices and for surface functionalisation **Prof. Andreas Lesch**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on various advanced micro- and nanofabrication methods used for the development and appliation of devices and functionalised surfaces in genral. Particular attention will be paid to electroanalytical and electrocatalytic systems, as well as photocatalytic materials currently envisioned for use in a wide range of energy convesion and storage devices. The course will also involve an active role for students.
Methodologies for modelling (photo)chemical processes **Prof. Marco Garavelli**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I. II	The training objectives of the course are to provide the student with skills on the thoretical framwork relating to the simulation of thermal and photoinduced reactions in molecular systems. This will encompass concepts such as potential energy surfaces and elctronic states, minima and transition states, reaction pathways and coordinates, deactivation events in phtoexcited molecules and branching of photoreactive processes. The arsenal of comuptational tools to map the reaction coordinates of photochemical processes will be illustrated. The course will also involve an active role for students.

Selecting procedures and experiments for optimal and sustainable chemical processes **Prof. Luca Ciacci**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on novel methodologies for the selection and design of experiments associated with chemical procedures and processes as well as develop and apply life cycle metrics and indicators supporting sustainability in the supply and use of natural resources and the reduction of environmental impacts. The course will also involve an active role for students.
Polymeric and composite materials: advanced thermochemical characterisation-Module 1 **Prof.ssa Laura Mazzocchetti**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on the potential of thermal (DSC, TGA), and rheological techniques with specific reference to their application in characterizing polymers and polymer-matrix composites. In this context students will also have the possibility to present their own case studies and discuss them with their colleagues in the audience and the teachers and experts in the specific application field.
Advanced modelling methods for chemical equipment design and examples of industrial applications **Prof.ssa Giuseppina Montante**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on computational fluid dynamics (CFD) for the simulation of industrial chemical equipment, including trasnport equations of mass, momentum, species and energy. Numerical modeling of laminar and turbulent flows; multiphase flows modelling; reactive flow modelling. CFD based design and optimisation of chemical reactors and separation units. The course will also involve an active role for students.

Advanced methods for the synthesis and characterisation of functional inorganic materials **Prof.ssa Cristina Femoni**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on functional inorganic materials, molecular or non-molecular compounds with some specific properties that can find applications in batteries, fuel cells, catalysts, gas storage, etc. This course aims at giving an overview of the principal techniques for the synthesis and characterization of such functional inorganic materials. The first part will be devoted to the description of selected methods for their synthesis. The second part will focus on some of the most employed characterization techniques. The course will also involve an active role for students.
Industrial organic chemistry **Prof. Luca Bernardi**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills in the field of industrial organic chemistry, preparing them for careers in chemical manufacturing, pharmaceuticals, materials science, and related industries. The student will also be able to devise industrially viable organic synthesis taking into considerations economic aspects and their ecofriendliness and sustainability. The course will also involve an active role for students.
Advances in catalysts and catalytic processes design **Prof. Nikolaos DImitratos**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on: (a) Fundamental of Catalysis, focusing on gold catalysis, Synthesis of nanoparticles using specific strategies based on colloidal methods. (b) Characterisation of nanoparticles and carbon functionalised materials and strategies to follow for controlling morphology of nanoparticles; (c) Catalytic applications focusing on biomass valorisation, for example glycerol oxidation, production of hydrogen using donor H molecules such as formic acid decomposition and photocatalytic applications. The course will also involve an active role for students.

Polymeric and composite materials: advanced thermochemical characterisation-Module 2 **Prof.ssa Chiara Gualandi**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on the viscoelastic properties of the polymeric materials and their mechanical characterization including creep, stress-relaxation and DMTA tests. In this context students will also have the possibility to present their own case studies and discuss them with their colleagues in the audience and the teachers and experts in the specific application field.
Modern NMR techniques **Prof. Andrea Mazzanti**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on a comprehensive theoretical knowledge, practical skills, and critical thinking abilities in the field of NMR spectroscopy. Students will delve into and apply a range of advanced NMR techniques, including 2D NMR, heteronuclear correlation, and multi-pulse sequences. Additionally, they will be introduced to software tools for spectral simulation, processing, and assignment. The course will also involve an active role for students.
Molecular approaches to sustainable catalysis **Prof.ssa Rita Mazzoni**	Disciplinary and multidisciplinary training	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on a critical analysis and description of catalytic molecular and hybrid approaches to massive transformation ranging from industrial application to rational design of novel sustainable processes. More specifically: (a) examples of current industrial processes, (b) the role of design in recent homogeneous, heterogenized or hybrid catalysis following the aim of energy and environmental transition and (c) a problem-solving approach will be finally implemented for some case studies.

Project management **Dr.ssa Daniela Sani** (ART-ER)	Tranversal skills	1,33	8	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on the set of activities, methodologies and tools aimed at achieving the project objectives, in compliance with the constraints determinedby the client, such as cost, time and purpose, The optimisation of the resources to be allocated will be covered, integrating the input necessary to achieve the objectives. The different approches in project management will be discussed, and the role of the Project manager.
Valorizzazione della proprietà intellettuale (Intellectual property valorisation) **Ing. Michele Rubbini** (Modiano & Partners)	Tranversal skills	1	6	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on advantages of the correct protection of intellectual property and patents, know-how, trademarks, models for the protection of design and their strategic and economic importance in modern industry and commerce. The course will be given in italian.
Comunicazione pubblica della scienza **Prof.ssa Laura Corazza**	Tranversal skills	1,67	10	eligibility	Jan-feb 2025	I, II	The training objectives of the course are to provide the student with skills on the valorization and dissemination of science, with particular reference to the chemical-industrial field. The topic of planning a training intervention will be discussed, in either a formal (school or university) and non-formal (territorial spaces and on the Internet) environment, in order to conceive and plan educational actions and the rooting of a scientific mentality. The main transmedia languages and some of the most significant experiences of contemporary scientific dissemination will be illustrated. The course will be given in Italian.