UNIVERSITÀ DEGLI STUDI DI PADOVA

PHD OF NATIONAL INTEREST IN TECHNOLOGIES FOR FUNDAMENTAL RESEARCH IN PHYSICS AND ASTROPHYSICS

EDUCATIONAL OFFER – A.Y. 2024/25

Curriculum: MECHANICS

- Advanced scientific programming in Matlab
- Thermo-fluid dynamics in 3D printed channels
- Coupled electrical-thermal-structural Finite Element Analyses
- Metal Additive Manufacturing
- Fundamentals of system engineering and project management for large scientific projects
- Generative Design for smart Additive Manufacturing
- Random Excitation and Response of Structures
- Statistical process monitoring of complex engineering data
- Optimization Methods for Mechanical Design
- 3D printed materials and their functional properties
- Advanced numerical modeling for systems engineering: theory and applications
- Structural simulation techniques in the dynamic and non-linear field
- Lattice Structures via Additive Manufacturing for Multifunctional Aerospace Components
- Analysis and Modeling of the Additive Manufacturing

Course unit English denomination	Advanced scientific programming in Matlab
Teacher in charge (if defined)	Paolo Bardella, Stefano Scialò
Teaching Hours	30
Number of ECTS credits allocated	6
Course period	January/February 2025
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☒ No
Course unit contents	1.5h: introduction to MATLAB, with particular attention on the improvements introduced in the latest versions 1.0h: source Control systems integrated in MATLAB (git) 1.5h: MATLAB internals: data structures, JIT, numerical libraries 3.0h: object oriented programming in MATLAB 3.0h: optimization of MATLAB code, use of the Code Profiler 3.0h: MEX files for the execution of C/C++ and Fortran code in MATLAB. MATLAB C code generator 3.0h parallel computing in MATLAB: introduction to parallel computing, commands parfor, spmd, advantages and limitations. 3.0h: GPUs in MATLAB: introduction to GPUs and gpuarray command 3.0h: optimization of I/O in MATLAB, control of hardware 3.0h: fundamentals of machine learning in MATLAB; Big data and tall arrays 1.0h: alternatives to MATLAB: python, Arrayfire, Gnu Scientific library, Octave, Scilab 4.0h: projects' presentation
Learning goals	The course aims to provide advanced skills in scientific programming, and to teach sound methodologies for the development of reliable, optimized and maintainable codes. During this course, many common methods used in Scientific Computing will be presented, with particular attention to the most recent programming techniques in MATLAB. At the end of the course, the student will have expanded his/her knowledge of MATLAB and will be able to choose the best approach for the solution of numerical problem he/she will face.
Teaching methods	Lectures
Course on transversal, interdisciplinary,	☒ Yes ☐ No

transdisciplinary skills	
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Basic knowledge of MATLAB language.
Examination methods (in applicable)	Presentation of group activity on the optimization of existing MATLAB code proposed by the students.
Suggested readings	Slides provided by the teachers, video recordings of the lessons, suggested texts on specific topics.
Additional information	-

Course unit English denomination	Thermo-fluid dynamics in 3D printed channels
Teacher in charge (if defined)	Simone Mancin
Teaching Hours	8
Number of ECTS credits allocated	1
Course period	February 2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (% minimum of presence) ☐ No
Course unit contents	Thermo fluid dynamics of printed channels and systems
Learning goals	Learn which are the most important parameter to control to design efficient 3D printed heat exchangers
Teaching methods	Lecture
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Thermodynamics and Heat Transfer
Examination methods (in applicable)	-
Suggested readings	Notes
Additional information	-

Course unit English denomination	Coupled electrical-thermal-structural Finite Element Analyses
Teacher in charge (if defined)	Giovanni Meneghetti, Mattia Manzolaro, Michele Ballan
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	June 2025
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (% minimum of presence) ☐ No
Course unit contents	Course overview and introduction. General aspects of Finite Element analyses related to the structural, thermal and electrical fields. Structural analyses with plane and solid elements. Thermal analyses with plane and solid elements, implementing thermal conduction, thermal convection and thermal radiation. Coupled field thermal-structural analyses. Coupled field electrical-thermal analyses. Coupled field electrical-thermal-structural analyses. Presentation of a complex test case implementing all the aforementioned physical fields with a specific focus on complex geometry import.
Learning goals	The course is aimed at providing the fundamental know-how for the performance of Multiphysics Finite Element analyses related to the structural, thermal and electrical fields. ANSYS® will be the adopted engineering simulation software.
Teaching methods	Frontal lesson and tutorial
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	-
Examination methods (in applicable)	Report on a project developed by the PhD student

Suggested readings	- M. Manzolaro, G. Meneghetti, A. Andrighetto, Thermal–electric numerical simulation of a surface ion source for the production of radioactive ion beams, Nucl. Instrum. Methods Phys. Res., Sect. A 623 (2010) 1061–1069. - G. Meneghetti, M. Manzolaro, A. Andrighetto, Thermal–electric numerical simulation of a target for the production of radioactive ion beams, Finite Elem. Anal. Des. 47 (2011) 559–570. - M. Manzolaro, G. Meneghetti, INTRODUCTION TO THE THERMAL ANALYSIS WITH ANSYS® NUMERICAL CODE, edizioni LIBRERIA PROGETTO, 2014, Padova, ITALY. - G. Meneghetti, M. Manzolaro, M. Quaresimin, INTRODUCTION TO THE STRUCTURAL ANALYSIS WITH ANSYS® NUMERICAL CODE, edizioni LIBRERIA PROGETTO, 2014, Padova, ITALY.
Additional information	-

Course unit English denomination	METAL ADDITIVE MANUFACTURING
Teacher in charge (if defined)	Eng. Pietro Rebesan
Teaching Hours	16
Number of ECTS credits allocated	4
Course period	Second semester A.Y. 2024/25
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	Italian/English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	The course provides students with the basic knowledge and skills for metal Additive Manufacturing (AM) including AM processes and their capabilities, raw materials production chain, designing AM parts according to design for additive manufacturing (DfAM) rules, AM software introduction, case study on materials production and characterization, main defects on additively manufactured metals components, simulation, and post-processing. Practical experience will be gained through individual projects and laboratory hands-on experience.
Learning goals	Understand the fundamental principles of metal additive manufacturing (AM). Identify AM processes and their capabilities. Analyze the raw materials production chain. Apply the principles of Design for Additive Manufacturing (DfAM). Use software for additive manufacturing. Evaluate case studies on AM materials production and characterization. Recognize common defects and post-processing phase in components produced via AM. Develop practical skills through individual or group projects.
Teaching methods	Lectures and exercises
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	no

Examination methods (in applicable)	Discussion/Report of a case study within the individual or group project
Suggested readings	Courses slides and papers recommended during the course
Additional information	

Course unit English denomination	Fundamentals of system engineering and project management for large scientific projects
Teacher in charge (if defined)	Marco Xompero / Runa Briguglio
Teaching Hours	12
Number of ECTS credits allocated	1,5
Course period	spring 2025
Course delivery method	x In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	x Yes (100% minimum of presence) ☐ No
Course unit contents	Today, scientific research projects are carried out by large international teams and involve a multi-disciplinary approach. In add, specific tools are requested: to organize the team-work, to meet the deadlines, to define a common language and comprehension across all the elements in the project. The system engineer and the project manager are key-figures in the organizational chart. System engineering is an approach for successful systems, focusing on the early analysis of the user needs, then proceeding with design synthesis and system validation considering the complete problem. Project management, in parallel, is related to the organizational aspects: the definition of who will be doing what and how, the creation and optimization of a project calendar, based on the activities prioritization and their conflicts, the identification and management of risks, and much more. The class is intended to provide PhD students with a basic package to understand the project's working mechanisms.
Learning goals	Project planning System management
Teaching methods	Slides and group work, analysis of use cases. The course is organized as a 2, 3 days workshop in Florence
Course on transversal, interdisciplinary,	x☐ Yes No

transdisciplinary skills	
Available for PhD students from other courses	☐ Yes x No
Prerequisites (not mandatory)	None
Examination methods (in applicable)	class work, organization of a custom project.
Suggested readings	None. References will be given during the classes
Additional information	https://sites.google.com/inaf.it/syseng-phdnazionale/home-page

Course unit English denomination	Generative Design for smart Additive Manufactruing
Teacher in charge (if defined)	Massimo Matrorelli
Teaching Hours	12
Number of ECTS credits allocated	3
Course period	January-February 2025
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	TBD
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	The course contents mainly cover the following two aspects. - Basic elements on Additive Manufacturing (AM): consolidated and emerging AM techniques. Process parameters and other aspects that can improve the result in term of accuracy, roughness and mechanical properties of AM parts. - Taking advantage of the AM processes which allow to manufacture ''complex'' geometries, in some cases unrealizable with other manufacturing processes, the course introduces to Generative Design (GD), a design method that mimics nature's evolutionary approach to design. GD is used to design complex shapes and optimized forms in relationship to forces, cost, weight and other data that may influence the design. Starting from design goals and using machine learning algotithms, GD explores all of the possible permutations of a solution to find the best option. GD alghoritms cycle through thousand – or even millions – of design choices, testing configurations and learning from each iteration what works and what doesn't. The process lets designers generate new options, beyond what a human alone could create, to arrive at the most effective design.
Learning goals	-
Teaching methods	Mixed Modality (physical + virtual)
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No

Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	-
Examination methods (in applicable)	-
Suggested readings	-
Additional information	http://www.dii.unina.it/page.php?tabella=livello3&id_livello=456&flag=pagina&livello1=7&livello2=131&livello3=0

Course unit English denomination	Random Excitation and response of structures
Teacher in charge (if defined)	Francesco Franco e Giuseppe Petrone
Teaching Hours	12
Number of ECTS credits allocated	3
Course period	September (TBC)
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	TBD
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	-
Learning goals	-
Teaching methods	Mixed Modality (physical + virtual)
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	-

Examination methods (in applicable)	-
Suggested readings	-
Additional information	http://www.dii.unina.it/page.php?tabella=livello3&id_livello=456&flag=pagina&livello1=7&livello2=131&livello3=0

Course unit English denomination	STATISTICAL PROCESS MONITORING OF COMPLEX ENGINEERING DATA
Teacher in charge (if defined)	Antonio Lepore, Christian Capezza
Teaching Hours	24
Number of ECTS credits allocated	6
Course period	max 3750 caratteri
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	• Univariate and Multivariate Statistical Process Monitoring (3 CFU) • Statistical Process Monitoring of Functional Data (3 CFU)
Learning goals	Training on the application (illustrated through open-source statistical software environment R) of statistical process monitoring of complex engineering data for decision-making. Every student must choose a data analysis project gathered during the course and develop it by working in a team. In this way, students will have the opportunity to improve their ability to recognize and implement the most suitable statistical techniques for the problem at hand, as well as to communicate relevant results and the impact of their analysis also to non-statisticians
Teaching methods	-
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☐ No
Available for PhD students from other courses	☐ Yes ☐ No
Prerequisites (not mandatory)	-
Examination methods (in applicable)	-

Suggested readings	- Montgomery, D.C. (2012). Introduction to Statistical Quality Control. John Wiley & Sons. - Johnson, R.A. & Wichern, D.W. (2007) Applied Multivariate Statistical Analysis, Pearson. - Ramsay, J.O. & Silverman, B.W. (2005) Functional Data Analysis, Springer.
Additional information	-

Course unit English denomination	Optimization Methods for Mechanical Design
Teacher in charge (if defined)	Giovanni Berselli
Teaching Hours	12
Number of ECTS credits allocated	3
Course period	every 2 years in March
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	- Introduction to optimization methods; - Design of Experiments, Response Surface Modelling; - Deterministic, stochastic optimization and multi-objective optimization; - Robust Design Analysis; - Guidelines for addressing an optimization problem in Engineering Design; - Introduction to the optimization tools integrated into CAD/CAE software; - Hands-on Experience via an application case study - design of parts with complex geometry and predefined structural compliance. o Method A: optimization using PTC Creo + Ansys WB. o Method B: optimization using a Matlab Script
Learning goals	Computer-Aided Design (CAD) and Engineering (CAE) software have unquestionably become essential tools for product design. CAD/CAE technologies are extensively used in several fields, including aerospace, automotive, earth-moving machines, and automated plants. Virtual prototypes can simulate mechanical and mechatronic systems starting from the geometrical and parametric representation of parts, the study of complex devices during their motion, up to the verification and the OPTIMIZATION of their behaviour. To date, various software environments are available (in some cases also open-source) that allow performing sensitivity/feasibility analyses, as well as mono/multi-objective optimization studies while integrating several simulation tools (i.e. parametric solid modelling, structural computations, motion analyses), thus allowing a faster and more efficient engineering design process and drastically reducing product development times. Within this scenario, this training course will allow to learn the basic background of the main engineering optimization techniques, also offering the possibility for hands-on training with some of the most popular CAD/CAE packages available for the scientific and industrial community.
Teaching methods	Mixed Modality (physical + virtual)
Course on transversal, interdisciplinary,	☒ Yes ☐ No

transdisciplinary skills	
Available for PhD students from other courses	☐ Yes ☐ No
Prerequisites (not mandatory)	-
Examination methods (in applicable)	-
Suggested readings	Lecture notes and video tutorials provided by the lecturers. - G. Pahl and W. Beitz, Engineering Design: A Systematic Approach, 2nd ed. Springer, 1998.
Additional information	https://www.imeg-dottorato.it/training-activities-1

Course unit English denomination	3D printed materials and their functional properties
Teacher in charge (if defined)	Fabrizio BARBERIS
Teaching Hours	12
Number of ECTS credits allocated	4
Course period	every 2 years in January
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	Principal targets in 3D printing: technical vs commercial - Introduction to Additive Manufacturing technologies - Intro to 3D metal printing - Microstructure of 3D printed metals and the industrial experience - 3D printing with polymers – the medical experience in tailored medicine with external and internal temporary scaffolds. - Main materials advantages and problems arising by 3D printing - Hands-on Experience via an application case study – the GeAM Project.
Learning goals	In the last 25 years Additive Manufacturing - AM matured as a technology able to deposit molded materials in a layer-by-layer process by following Project instruction provided by a virtual solid model. AM was originally born as a substitute of Rapid Prototyping techniques when the target was mainly to obtain a solid shape of the discussed project. To date the situation is different and AM is adopted to create functional parts not only in general industrial applications but also in sensitive tasks like energy, transports, aerospace and also medicine. Different names are used, Direct Manufacturing as well as Advanced Manufacturing, to generally indicate the AM process but the adopted technologies are quite different and therefore also the possible benefits. The main attractive item of AM is the chance to rebuild the Project by applying this new technology but a serious limit exists in the final microstructure of the printed materials and therefore in the overall mechanical and functional properties. The Course will evaluate the main technologies available on the market to print polymers and metals, highlighting the main features and differences in terms of the material microstructure and the overall mechanical and functional properties. Analysis of the main features of 3D printed materials as well as problems related to these technologies will be discussed with the students, commenting several examples coming from the industry as well as from medical applications. GeAM - Genova Additive Manufacturing facilities will be introduced and shown to the students in order to enhance the overall Course experience
Teaching methods	Mixed Modality (physical + virtual)
Course on transversal, interdisciplinary,	☒ Yes ☐ No

transdisciplinary skills	
Available for PhD students from other courses	☐ Yes ☐ No
Prerequisites (not mandatory)	-
Examination methods (in applicable)	-
Suggested readings	Lecture notes and video tutorials provided by the teacher
Additional information	https://www.imeg-dottorato.it/training-activities-1

Course unit English denomination	Advanced numerical modeling for systems engineering theory and applications
Teacher in charge (if defined)	Dalla Vedova Matteo Davide Lorenzo
Teaching Hours	20
Number of ECTS credits allocated	-
Course period	JANUARY- FEBRUARY - MARCH
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	1. Introduction of the course Technical-scientific framework of the problem: Systems engineering Onboard systems Numerical modelling Historical overview regarding the development of survey techniques in engineering applications Why Matlab-Simulink? Multidomain Numerical Simulation Environment Simulink for System Modeling and Simulation Introduction to the use of Matlab-Simulink 2. Numerical modelling techniques Critical analysis of the different methodologies: advantages/disadvantages and limits of use Selection strategy (use destination, level of detail, accuracy, computational costs) 3. Lumped parameters umerical modelling Introductory notes Physical-mathematical models Physical-functional diagrams (graphical representations and references to the Bond Graphs) Basic notions of block diagrams: Proposed examples Comparison with Simulink graphical programming language 3.1. Some applicative examples (from the aerospace field) 4. Simplified numerical models Models detail levels and their use High Fidelity (HF) and Low Fidelity (LF) models Some model simplification techniques 4.1. Some applicative examples (referring to the cases seen in 3.1) 5. Monitoring, diagnostics and prognostics of systems Generalities, classification and specific characteristics Diagnostic and prognostic algorithms 5.1. Some applicative examples 5.2. Final test assignment 6. Final Evaluation Sharing of the students' proposals Critical analysis of the different solutions
Learning goals	The use of lumped parameters numerical modelling tools, designed to simulate the dynamic response of a given system, is now a consolidated practice in the engineering environment, and today it is a fundamental and essential tool in many phases of the definition and development process of a project. Especially in complex dynamic systems (composite and strongly interconnected architectures, marked interdisciplinary connotations, strongly non-linear dynamics), this approach allows to support the different phases of the project, providing a versatile tool, easily reconfigurable and able to integrate easily with the usual development methodologies (analytical and / or empirical models, experimental data). In particular, these methodologies are now widely used in the systems engineering field (e.g. aerospace, mechanics, mechatronics, automation, etc.) during the preliminary design, the detailed modeling of components or subsystems, the development of dedicated control logics and the conception of simplified numerical models able to perform different functions (monitoring, diagnostics, prognostics, optimization algorithms). As regards the onboard

	systems, these algorithms are often implemented in the resident management software of the aircraft: therefore it was necessary to define appropriate certification and software development strategies aimed to guarantee suitable levels of safety and reliability. From an operational point of view, the course will be structured according to an “active” educational approach, proposing an alternation between classical lectures, computer-based group experiences (by using programs developed in Matlab-Simulink) and individual activities. This approach aims to provide students with the technical-scientific bases and skills (theoretical and practical) necessary to begin to effectively understand and autonomously develop the numerical modelling of a complex system and/or simple diagnostic algorithms. In addition to focusing on the various fundamental conceptual aspects, several application examples (deriving from selected case studies) will be discussed during the lectures to encourage the students developing the critical approach and the "sensitivity" necessary to operate in this field.
Teaching methods	-
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☐ No
Available for PhD students from other courses	☐ Yes ☐ No
Prerequisites (not mandatory)	A multidisciplinary approach to engineering and (at least) basic knowledge of Matlab-Simulink can allow an easier and more profitable elaboration of the proposed topics.
Examination methods (in applicable)	-
Suggested readings	-
Additional information	-

Course unit English denomination	Structural simulation techniques in the dynamic and non-linear field
Teacher in charge (if defined)	Peroni Lorenzo
Teaching Hours	18
Number of ECTS credits allocated	-
Course period	-
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	Italian
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	-
Learning goals	The course aims to describe the basic principles and main numerical techniques necessary for the understanding and application of the finite element method (FEM) with special emphasis on dynamic and transient nonlinear structural analysis. During the course, both the theoretical foundations and numerous applications in various fields will be illustrated through the discussion of numerical examples and specific case studies solved with the aid of the Ansys LS-DYNA software. The notions learned will make it possible to explore the possible applications of the methods and aspects discussed in various fields of engineering.
Teaching methods	-
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☐ No
Available for PhD students	☐ Yes ☐ No

from other courses	
Prerequisites (not mandatory)	Conoscenze di calcolo numerico (metodi di approssimazione, tecniche di interpolazione, integrazione numerica, strumenti del calcolo scientifico per la risoluzione di equazioni alle derivate parziali), fondamenti di meccanica strutturale (caratteristiche meccaniche e di resistenza dei materiali, stato di tensione e di deformazione in campo lineare elastico) e meccanica dei materiali (comportamento elastico-plastico, modelli di flusso plastico, metodologie di cedimento).
Examination methods (in applicable)	-
Suggested readings	-
Additional information	https://didattica.polito.it/pls/portal30/gap.pkg_guide.viewGap?p_cod_ins=01HIYRO&p_a_acc=2024&p_header=S&p_lang=IT&multi=N

Course unit English denomination	Lattice Structures via Additive Manufacturing for Multifunctional Aerospace Components
Teacher in charge (if defined)	Ferro Carlo Giovanni
Teaching Hours	15
Number of ECTS credits allocated	-
Course period	June
Course delivery method	☐ In presence ☐ Remotely ☒ Blended
Language of instruction	English
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	Week 1 • Introduction to Lattice Structures and Aerospace Applications • Overview of Additive Manufacturing Technologies • Fluid Dynamics in Aerospace & Heat Exchangers Week 2 • Structural Analysis of Lattice Structures • Manufacturability Constraints in Additive Manufacturing • Sensors and Smart Materials: Introduction to FBG Sensors Week 3 • Design and Analysis Tools for Multidisciplinary Optimization • Case Studies: Real-world Aerospace Applications • FBG Sensors in Aerospace: Methods and Challenges Week 4 • Research Methodologies: From Hypothesis to Experimentation • Workshop: Developing Your Research Proposal Week 5 • Final Presentations and Peer Review
Learning goals	This advanced PhD course aims to delve into the multifaceted realm of lattice structures manufactured through additive manufacturing (AM) techniques, particularly focused on their applications in aerospace engineering. Through a multidisciplinary lens, this course will tackle the challenges and potentials in optimizing various functions such as heat exchange, structural integrity, and manufacturability. The course also aims to introduce also embedding of Fiber Bragg Grating (FBG) sensors for realizing smart components. It will conclude with an individual research project and peer-reviewed presentations.
Teaching methods	-
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☐ No

Available for PhD students from other courses	☐ Yes ☐ No
Prerequisites (not mandatory)	- Basics of Additive Manufacturing - Introduction to Aerospace Engineering - Fundamentals of Fluid Dynamics and Structural Analysis - Research Methodologies in Engineering
Examination methods (in applicable)	-
Suggested readings	-
Additional information	https://didattica.polito.it/pls/portal30/gap.pkg_guide.viewGap?p_cod_ins=01HVVIW&p_a_acc=2024&p_header=S&p_lang=IT&multi=N

Course unit English denomination	Analysis and Modelling of the Additive Manufacturing
Teacher in charge (if defined)	Daniele Tammaro
Teaching Hours	12
Number of ECTS credits allocated	2
Course period	Feb-Mar
Course delivery method	☐ In presence ☐ Remotely ☐ Blended
Language of instruction	-
Mandatory attendance	☐ Yes (% minimum of presence) ☐ No
Course unit contents	-
Learning goals	-
Teaching methods	-
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☐ No
Available for PhD students from other courses	☐ Yes ☐ No
Prerequisites (not mandatory)	-
Examination methods (in applicable)	-
Suggested readings	-
Additional information	https://www.dicmapi.unina.it/dottorato/dottorato/formazione/