PhD Courses - Active Cycles

Note : Students are required to indicate their interest in scheduled courses in advance by sending an email to the course instructor. Reservations will begin 1 month in advance and will be closed 15 days before the date or period scheduled for the start of the course. PhD students who are abroad (e,g, for study periods at Universities or companies) are invited to notify the instructor to activate on line teaching.

YEAR	PHD CURRICULUM	TITLE	SSD	TEACHER	CONTACTS	CREDITS-HOURS	COURSE TYPE	LANGUAGE
1st Year- Basic Courses covering aspects related to advanced mathematics and statistics, numerical computation methods, measurent and experimentation methods	ALL	Tensor Calculus	IIND-01/F	Gerardo Paolillo	gerardo.paolillo@unina.it	3 – 12	Basic	English
		Fundamentals of Applied Optics	IIND-01/F	Carlo Salvatore Greco	carlosalvatore.greco@unina.it	3 – 12	Basic	English
		Design and Analysis of Experiments for Product Innovation	SECS-S/02	Amalia Vanacore	vanacore@unina.it	3 – 12	Basic	English
		Advanced digital modeling and generative design	IIND-03/B	Fabrizio Renno	fabrenno@unina.it	6 – 24	Basic	English
		Progettazione e comunicazione della Misura	IIND-07/B	Marilena Musto	marmusto@unina.it	4 – 16	Basic	Italian
		Come gli approcci del Project Management possono essere utilizzati per la programmazione, il monitoraggio e la valutazione dei progetti di ricerca?	IEGE-01/A	Guido Capaldo	gcapaldo@unina.it	4 – 16	Basic	Italian
		Research methodologies for complex systems	IEGE-01/A	Cristina Ponsiglione / Simonetta Primario	ponsigli@unina.it; simonetta.primario@unina.it	3 – 12	Basic	English
	Aerospace and Naval Engineering	Scaling and Similitudes for Structural Dynamics and Vibroacoustics	IIIND-01/D	Sergio de Rosa e Alessandro Casaburo	derosa@unina.it; alessandro.casaburo@unina.it	3 – 12	Characterising	English
		Special Topics in Aerospace Systems	IIND-01/E	Alessia Nocerino/Giorgio Isoletta	alessia.nocerino@unina.it; giorgio.isoletta@unina.it	3 – 12	Characterising	English
		Thermal protection systems for hypersonic flight and propulsion	IIND-01/F/G	Stefano Mungiguerra e Anselmo Cecere	stefano.mungiguerra@unina.it; anselmo.cecere@unina.it	3 – 12	Characterising	English
		Sustainable and green future air vehicle	IIND-01/C	Pierluigi Della Vecchia Salvatore Corcione Vincenzo Cusati Fabrizio Nicolosi	pierluigi.dellavecchia@unina.it salvatore.corcione@unina.it; fabrnico@unina.it; vincenzo.cusati@unina.it	3 – 12	Characterising	English
		Machine Learning in Vibroacoustics	IIND-01/D	Alessandro Casaburo	alessandro.casaburo@unina.it	3 – 12	Characterising	English
		Random Excitation and Response of Structures	IIND-01/D	Francesco Franco Giuseppe Petrone	francof@unina.it; giuseppe.petrone@unina.it	3 – 12	Characterising	English
		Dynamic simulation techniques for marine	IIND-01/B	Maria Acanfora/ Marco Altosole	maria.acanfora@unina.it; marco.altosole@unina.it	3 – 12	Characterising	English

2/3nd Year		Advances in ship seakeeping	IIND-01/A	Ermina Begovic	begovic@unina.it	3 – 12	Characterising	English
	Energy and Mechanical Engineering	Vehicle Kinematics & Dynamics: Physics and Modelling	IIND-02/A	Francesco Timpone / Aleksandr Sakhnevych	timpone@unina.it; aleksandr.sakhnevych@unina.it	5 – 20	Characterising	English
		Vehicle Dynamics Outdoor Testing and Mult physical Modelling	IIND-02/A	Flavio Farroni / Andrea Genovese	flavio.farroni@unina.it; andrea.genovese2@unina.it	5 – 20	Characterising	English
		Soluzioni attuali e future per una propulsione automobilistica sostenibile	IIND-06/A	Fabio Bozza / Vincenzo De Bellis	fbozza@unina.it; vincenzo.debellis@unina.it	3 – 15	Characterising	Italian
		Tecniche numeriche per l'analisi e il progetto delle turbine eoliche	IIND-06/A	Rodolfo Bontempo	rodolfo.bontempo@unina.it	3 – 12	Characterising	Italian
		Conversione di Risorse Energetiche Rinnovabili con Micro-Turbine a Gas	IIND-06/A	Maria Cristina Cameretti / Roberta De Robbio Raffaele Tuccillo	camerett@unina.it; roberta.derobbio@unina.it; tuccillo@unina.it	3 – 12	Characterising	Italian
		Generative Design for Smart Additive Manufacturing	IIND-03/B	Antonio Gloria	angloria@unina.it	3 – 12	Characterising	English
		Design for soft robotics	IIND-03/B	Stanislao Grazioso	stanislao.grazioso@unina.it	3 – 12	Characterising	English
		Characterization of the acoustic behaviour of porous materials	IIND-07/A	Raffaele Dragonetti Elio Di Giulio	dragonet@unina.it; elio.digiulio@unina.it	4 – 16	Characterising	English
		Novel Smart Renewable Energy Networks	IIND-07/A	Maria Vicidomini / Luca Cimmino	maria.vicidomini@unina.it; luca.cimmino@unina.it	6 – 24	Characterising	English
		Solid-state Cooling	IIND-07/A	Claudia Masselli	claudia.masselli@unina.it	4 – 18	Characterising	English
		Indoor Environmental Quality: an olistic approach to comfort and safety	IIND-07/B	Boris Igor Palella	palella@unina.it	4 – 18	Characterising	English
	Engineering Management, Quality and Data Science for Technology	Statistical process monitoring of high-dimensional engineering data	SECS-S/02	Antonio Lepore Christian Capezza	antonio.lepore@unina.it; christian.capezza@unina.it	6 – 24	Characterising	English
		Innovation and Entrepreneurship	IEGE-01/A	Pierluigi Rippa	pierippa@unina.it	3 – 12	Characterising	English

COURSE DETAILS

" SOLID-STATE COOLING "

SSD IIND-07/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof/Ing. Claudia Masselli**
PHONE: 0817682380 ; +393381995556
EMAIL: claudia.masselli@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 4
COURSE DURATION [NUMBER OF HOURS]: 18

PREREQUISITES
Basic knowledge of thermodynamics

LEARNING GOALS
This course will give the main tools for the comprehension of the physical phenomenon and the thermodynamics of the solid-state cooling and air conditioning, the comprehension of the physical phenomena of the caloric effects as well as a description of the experimental and numerical achievements accomplished by scientific community, with the final aim to provide perspectives about future challenges and progresses to be made.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The course provides students with advanced knowledge and methodological tools needed to analyze the thermodynamics of solid-state cooling, to understand the mechanisms behind caloric effects (magnetocaloric, electrocaloric, elastocaloric, barocaloric) and to critically evaluate the advantages and limitations of such technologies compared to traditional systems.

Applying knowledge and understanding
The course develops the ability to apply the acquired knowledge to analyze and solve practical problems related to the design and optimization of solid-state cooling systems. Students will be able to perform basic evaluations of thermodynamic cycles, interpret experimental data, and critically use numerical and analytical tools for performance prediction.

COURSE CONTENT/SYLLABUS
The course draws up a general framework on solid-state caloric cooling and heat pumping, a promising class of technologies aiming to replace vapor compression one. Over the last three decades, this technology has progressively gained remarkable attention since, taking vapor compression as reference, caloric refrigeration holds a potential for: improvements in energy efficiency, reduction of environmental impact because of the employment of solid-state materials, presenting no Ozone Depletion Potential and direct zero Global Warming Potential.

Introduction and thermodynamic cycles for solid-state cooling
Magnetocaloric cooling
Electrocaloric cooling
Mechanocaloric cooling: Elastocaloric and Barocaloric
State of the art, experimental and numerical achievements
Future challenges of technology

READINGS/BIBLIOGRAPHY

C. Aprea, A. Greco. A. Maiorino, C. Masselli, (2020) "Magnetocaloric as Solid-State Cooling Technique for Energy Saving", in the book Global Issues and Innovative Solutions in Healthcare, Culture, and the Environment, ISBN13: 9781799835769, ISBN10: 1799835766, EISBN13: 9781799835783, DOI: 10.4018/978-1-7998-3576-9, 2020, ed. IGI Global, Hershey, Pennsylvania 17033-1240, USA.

L. Cirillo, A. Greco, C. Masselli, (2023) "Numerical modeling and design of regenerative electrocaloric coolers". in the book The Electrocaloric Effect (pp. 359-377). ISBN: 978-0-12-821647-7 (print), ISBN: 978-0-12-821648-4 (online). DOI: https://doi.org/10.1016/B978-0-12-821647-7.00016-5 . ed. Woodhead Publishing, Elsevier.

L. Cirillo, A. Greco, C. Masselli, "The use of the barocaloric effect for refrigeration: an evaluation of the energy performances and environment impact" (pp.9-1/9-22). ISBN: 978-0-7503-4689-4. DOI: https://doi.org/10.1088/978-0-7503-4690-0

TEACHING METHODS

The course will be delivered through a combination of frontal lectures and interactive discussions. Lectures will be complemented by the analysis of case studies and recent research works. A practical sessions focused on the interpretation of experimental and numerical results may be included.

EXAMINATION/EVALUATION CRITERIA

Written examination. The examination will require a multiple choice test.

COURSE DETAILS

"CHARACTERIZATION OF THE ACOUSTIC BEHAVIOUR OF POROUS MATERIALS"

SSD IIND-07/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Raffaele Dragonetti e Elio Di Giulio**
PHONE: +39 0817682291
EMAIL: dragonet@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 4
COURSE DURATION [NUMBER OF HOURS]: 16

PREREQUISITES
Basic knowledge of acoustics and thermodynamics

LEARNING GOALS
The course aims to provide theoretical, numerical and experimental methods to characterize the thermo-acoustic behaviour of materials used for acoustic applications. Acoustic models for porous materials with a solid and elastic matrix will be introduced, as well as interaction of porous materials with external sound fields. Methods to measure the acoustics coefficients of absorption and transmission and the main transport parameters (such as viscous and thermal permeability, porosity, tortuosity and thermal and viscous characteristic lengths) will be introduced.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
The course aims to provide theoretical, numerical and experimental methods to characterize the thermo-acoustic behaviour of materials used for acoustic applications.
Key aspects include basic aspect of acoustic models for porous materials with rigid or elastic solid matrices, interaction of porous materials with external three-dimensional sound fields, basic aspect to experimentally determine sound absorption and transmission coefficients, as well as transport parameters such as porosity, tortuosity, viscous and thermal permeability, thermal and viscous characteristic lengths.
Students will learn the fundamentals for modelling sound propagation in porous media by introducing the concept of an equivalent fluid with complex intrinsic properties to account for phase shifts (propagation) and attenuation (dissipation in viscous media). Experimental characterization methods, including those developed in the research activity of the lecturers, will also be presented alongside examples of real porous material models.

Knowledge and understanding
The course provides students with theoretical and methodological tools to analyze the propagation of sound in porous materials. These tools will help students understand causal relationships between the physical properties of materials and their acoustic behaviour, with the ability to elaborate on concepts to be applied on acoustic material design and performance.

Applying knowledge and understanding
The course fosters practical competence enabling students to model acoustic absorption and insulation performance of porous materials. The interactive lessons encourage students to apply physical and mathematical background to simulate real-case acoustic phenomena in porous media.

COURSE CONTENT/SYLLABUS

Date	Time	Topic
27/05/25	10:00 – 13:00	Fundamentals of linear acoustics and introduction to porous materials
29/05/25	10:00 – 13:00	Wave propagation in simple pore
03/06/25	10:00 – 13:00	Wave propagation inside a rigid/elastic skeleton porous material
05/06/25	10:00 – 13:00	Interaction of porous materials with external sound fields
10/06/25	10:00 – 14:00	Measurement methods

READINGS/BIBLIOGRAPHY
- Atalla, N., & Allard, J. F. (2015). Propagation of Sound in Porous Media: Modelling Sound Absorbing Materials (2nd ed.). Wiley.
- Beranek, L. L. (1993). Acoustics (Reprint of 1954 edition). Acoustical Society of America.
- Fahy, F., & Gardonio, P. (2007). Sound and Structural Vibration: Radiation, Transmission and Response (2nd ed.). Academic Press.

- Di Giulio, E., Perrot, C., & Dragonetti, R. (2024). Transport parameters for sound propagation in air saturated motionless porous materials: A review. *International Journal of Heat and Fluid Flow*, *108*, 109426. https://doi.org/10.1016/J.IJHEATFLUIDFLOW.2024.109426
- Di Giulio, E., Napolitano, M., Di Meglio, A., Romano, R.A., Dragonetti, R. (2022). Low frequency acoustic method to measure the complex density of porous materials. Journal of the Acoustical Society of America, 152, pp. 2220-2226. https://doi.org/10.1121/10.0014762
- Napolitano, M., Di Giulio, E., Auriemma, F., Romano, R.A., Dragonetti, R. (2022). Low frequency acoustic method to measure the complex bulk modulus of porous materials. Journal of the Acoustical Society of America, 151, pp. 1545-1556. https://doi.org/10.1121/10.0009767
- R. Dragonetti, C. Ianniello, R.A. Romano, Measurement of the resistivity ofporous materials with an alternating air-flow method, J. Acoust. Soc. Am. 129(2) (2011) 753,http://dx.doi.org/10.1121/1.3523433
- B.H. Song, J.S. Bolton, A transfer-matrix approach for estimating the characteris-tic impedance and wave numbers of limp and rigid porous materials, J. Acoust.Soc. Am. 107 (3) (2000) 1131,http://dx.doi.org/10.1121/1.428404.
- O. Doutres, Y. Salissou, N. Atalla, R. Panneton, Evaluation of the acoustic andnon-acoustic properties of sound absorbing materials using a three-microphoneimpedance tube, Appl. Acoust. 71 (6) (2010) 506–509,http://dx.doi.org/10.1016/J.APACOUST.2010.01.007.

TEACHING METHODS
- Interactive frontal lectures with slides alternating theoretical background (equations) and graphical representations (pressure/velocity profiles, colormaps).
- Use of animated visualizations to illustrate acoustic behaviour in porous materials.
- Continuous involvement of students through questions, discussions, and coding exercises.

EXAMINATION/EVALUATION CRITERIA
Oral examination.
Students will present and discuss a scientific article of their choice relevant to the course content. The student will explain the article and may be asked to implement part of the model or analysis presented in the paper.

COURSE DETAILS

" ADVANCED DIGITAL MODELING AND GENERATIVE DESIGN "

SSD IIND-03/B

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: I
PHD CURRICULUM: ALL CURRICULA

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: PROF. FABRIZIO RENNO
PHONE: 081/7682459
EMAIL:fabrizio.renno@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 6
COURSE DURATION [NUMBER OF HOURS]: 24

REQUIRED PRELIMINARY COURSES
None

PREREQUISITES
None

LEARNING GOALS
- *Knowledge of the theoretical principles of Generative Design and geometric optimization*
- *Ability to create parametric-generative models by means of advanced CAD software.*
- *Practical experience in using software for simulations and analysis of generative models for industrial applications.*
- *Capacity for critical analysis and independent assessment of the strengths and limitations of generative design solutions in an industrial context.*
- *Ability to work in interdisciplinary teams for advanced product development.*

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
The course provides students with the knowledge and basic methodological tools necessary for analyzing and consolidating their understanding of advanced digital modeling techniques for virtual prototyping and generative design.

Applying knowledge and understanding
The student will have to demonstrate the ability to interpret and set up complex CAD models and use Generative Design techniques to generate multiple alternative candidate solutions for the manufacturing of industrial components through an interdisciplinary approach.

COURSE CONTENT/SYLLABUS
- *Advanced CAD Tools and Software for Digital Design*
- *Artificial Intelligence and Machine Learning for Generative Design*
- *Generative Design - Methods and software*
- *Creating Generative Models - Practical Exercises and Projects*
- *Generative Design and Python*
- *Final project: Development of project work*

READINGS/BIBLIOGRAPHY
Course notes.
UNI, ISO, EN standards.
Assignments and tutorials available on the teacher's website.

TEACHING METHODS
The course is based on the balance between frontal classroom teaching and computer lab exercises. In particular, thanks to the use of 3D CAD software, students are enabled to create complex and detailed parametric CAD models then used by means of KBE and Generative Design tools. The models developed then make it possible to carry out multidisciplinary activities based on the skills acquired during the course through FEM, Topological Optimization, KBE, AI and generative AI tools.

EXAMINATION/EVALUATION CRITERIA
Discussion of a final project and written test with multiple choice answers.

COURSE DETAILS

"DESIGN AND ANALYSIS OF EXPERIMENTS FOR PRODUCT INNOVATION "

SSD: STAT-01/B

PHD COURSE IN INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: I
COURSE TYPE: ALL CURRICULA

GENERAL INFORMATION – TEACHER REFERENCES

Prof. Amalia Vanacore
e-mail: amalia.vanacore@unina.it
url: www.docenti.unina.it/amalia.vanacore

GENERAL INFORMATION ABOUT THE COURSE

COURSE LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION: 12 HOURS

PREREQUISITES
*To successfully participate in the course, students are expected to have knowledge in **basic statistics** and **probability theory**, including familiarity with concepts such as hypothesis testing, confidence intervals and linear regression.*

While not mandatory, involvement in experimental research activities will be beneficial for contextualizing the course content and developing the final project.

LEARNING GOALS
The course introduces the techniques for the design of experiments and the analysis of the data using examples drawn from the industrial field. The focus is on how to design experiments, carry them out, and analyze the collected data. The course is organized in two modules of 6 hours each. In the first module, various designs are discussed to highlight differences, advantages, and disadvantages. Factorial and fractional designs are discussed in greater details. The second module focuses on the analysis and interpretation of experimental data. The methods are fully illustrated via examples; more complex applications are discussed through real case studies.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The course provides students with advanced knowledge and methodological tools essential for the design, planning, and analysis of experiments in complex research contexts. Students will deepen their understanding of experimental design principles, including randomization, replication, and blocking, as well as modern statistical models used for analyzing experimental data. Such knowledge allows students to critically evaluate the strengths and limitations of different experimental strategies, investigate the impact of experimental factors on observed responses, and understand the implications of design choices on statistical inference, reproducibility, and generalizability of research findings.

Applying knowledge and understanding
The course provides students with the competence to apply experimental design techniques and statistical methods to real-world and interdisciplinary research problems. Students will gain the ability to define robust experimental protocols and plan rigorous experiments, choose appropriate models for analysis, interpret outputs from statistical software, and communicate results effectively. The course encourages the development of original solutions to complex experimental problems, fostering the use of methodological tools to optimize design efficiency, ensure robustness, and support evidence-based decision making across various scientific and industrial domains.

COURSE CONTENT/SYLLABUS
Design of Experiments. *Guidelines for Designing Experiments. Randomized Blocks, Latin Squares, and Related Designs. Factorial Design. Fractional Factorial Designs. Robust Parameter Design.*
Analysis of Experiments. *Analysis of Variance. Response Surface Methods. Fixed Effects Models.*

READINGS/BIBLIOGRAPHY
Montgomery, D.C. (2019). Design and Analysis of Experiments, 10th Edition. John Wiley & Sons.

EXAMINATION
The final examination will consist in a team-based project in which students collaboratively develop, present and discuss a case study involving the application of at least one of the experimental design and analysis methods covered in the course. Whenever possible, the project should be connected to the

students' ongoing doctoral research, allowing them to integrate course content with their specific research contexts and challenges

COURSE DETAILS

" DYNAMIC SIMULATION TECHNIQUES FOR MARINE APPLICATIONS"

SSD IIND-01B

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: PROFS. MARCO ALTOSOLE AND MARIA ACANFORA
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GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge of marine engineering

LEARNING GOALS
The aim of the course is to present some simulation approaches for the dynamic modeling of the ship, recently used in the industrial field for the design and management of complex systems. After a brief introduction to marine propulsion systems, some theoretical and practical models for the numerical representation of engines, propeller and ship motions will be described. In particular, the aspects related to the propulsion control and the safety of the ship will be addressed.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
Upon completion of this course, PhD candidates will be able to:
- *Demonstrate a systematic understanding of the theoretical foundations and practical applications of dynamic simulation techniques specifically tailored for marine propulsion systems and ship motion.*
- *Critically analyze and evaluate advanced concepts related to the numerical representation of marine engines, propellers, and ship dynamics.*
- *Possess in-depth knowledge of current dynamic simulation approaches used for the design, management, and safety assessment of complex marine systems.*

Applying knowledge and understanding
Upon completion of this course, PhD candidates will be able to:
- *Apply advanced simulation methodologies to develop dynamic models of marine vessels and their propulsion systems.*
- *Independently design and implement numerical models for engines, propellers, and ship motions, integrating aspects of propulsion control and ship safety.*

COURSE CONTENT/SYLLABUS
Ship and Propeller Dynamics (M. Acanfora, 6h)
- *Module 1: Advanced Ship Dynamics and Propeller-Hull Interaction*
- *Module 2: Ship Maneuvering Simulation and Control*

Marine Engines and Propulsion Control (M. Altosole, 6h)
- *Module 3: Modeling of Marine Propulsion Systems*
- *Module 4: Propulsion Control and System Integration for Marine Applications*
.

READINGS/BIBLIOGRAPHY
Dynamics of a Rigid Ship - with applications by J. Matusiak available at https://urn.fi/URN:ISBN:978-952-64-0399-1.

TEACHING METHODS
Lectures

EXAMINATION/EVALUATION CRITERIA
Oral examination

COURSE DETAILS

" NOVEL SMART RENEWABLE ENERGY NETWORKS "

SSD IIND-07/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Maria Vicidomini, Dr. Luca Cimmino**
PHONE: +393409030070/+393451517081
EMAIL: maria.vicidomini@unina.it, luca.cimmino@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU:6
COURSE DURATION [NUMBER OF HOURS]: 24

PREREQUISITES (IF APPLICABLE)
Basic knowledge of thermodynamics

LEARNING GOALS
Acquired knowledge in Novel smart renewable energy networks. The course aims to provide students with an in-depth understanding of recent innovations in smart renewable energy networks, with a particular focus on technologies and strategies that enhance grid balancing. Special attention is given to fourth- and fifth-generation district heating and cooling networks, which play a crucial role in decarbonizing the residential sector when integrated with renewable energy sources. Within this context, key concepts such as Power-to-X (PtX), the water-energy nexus, and green hydrogen production will be explored as essential components for energy storage and grid flexibility. PtX technologies offer a promising solution for converting surplus renewable energy – otherwise subject to curtailment – into storable and versatile forms such as hydrogen, synthetic fuels, heat, and water, thereby improving grid stability and system adaptability. In addition, the course will examine advanced and emerging renewable technologies that are compatible with future energy networks, evaluating their technical and economic feasibility. Finally, systems based on waste-to-energy and bio-circular economy principles will be addressed as integral solutions for the decarbonization of key energy sectors.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The course provides students with in-depth knowledge and methodological tools to analyze novel renewable energy networks and their role in the decarbonization of the energy system. These tools will enable students to grasp the causal connections between technological innovation, grid flexibility, and sectoral integration, particularly in the context of Power-to-X systems, green hydrogen production, and next-generation thermal networks. Students will be able to critically interpret the implications of integrating these solutions into the broader energy infrastructure and reflect on their potential impacts from both technical and socio-economic perspectives.

Applying knowledge and understanding
The course equips students with the ability to apply their acquired knowledge to real-world scenarios by using quantitative and qualitative methods for evaluating advanced energy networks. Students will develop competence in applying concepts such as energy balancing, energy storage, and sector coupling through case studies, simulation tools, and critical assessment of renewable technologies. This practical approach fosters the ability to propose and evaluate innovative solutions in diverse contexts, including urban energy systems and industrial applications.

COURSE CONTENT/SYLLABUS
Total CFU: 6

Topic	Content Description	CFU
Introduction to Smart Renewable Energy Networks	*Overview of energy transition and smart energy systems; role of digitalization and decentralization*	*0.5*
District Heating and Cooling	*Focus on 4th and 5th generation networks, sector coupling with renewables*	*1.0*
Power-to-X Pathways	*Detailed study of PtX technologies: hydrogen, synthetic fuels, water-energy nexus*	*1.0*
Energy Storage and Grid Balancing	*Thermal, chemical, and electrical storage technologies and their role in flexible energy systems*	*1.0*
Advanced Renewable Technologies	*Integration of waste-to-energy, bio-circular economy, and novel renewable sources*	*1.0*
Case Studies and Applied Analysis	*Technical-economic feasibility assessment of smart networks through real-world examples*	*1.5*

READINGS/BIBLIOGRAPHY

[1]   Exergy and thermoeconomic analysis of a novel polygeneration system based on gasification and power-to-x strategy, Cimmino, L., Barco Burgos, J., Eicker, U., Renewable Energy, 2024, 236, 121438.

[2]   Analysis of the Impact of Funding Policies for the Energy Refurbishment of Buildings Using Dynamic Simulations, Calise, F., Cappiello, F.L., Cimmino, L., Vicidomini, M., Applied Sciences (Switzerland), 2024, 14(19), 8900.

[3]   Thermoeconomic analysis of a novel topology of a 5th generation district energy network for a commercial user, F. Calise, F.L. Cappiello, L. Cimmino, M. Vicidomini, F. Petrakopoulou, Applied Energy, 2024, 371, 123718.

[4]   Dynamic analysis and thermoeconomic optimization of a Power-to-Gas system driven by renewables, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energy Conversion and Management, 2024, 313, 118647.

[5]   Thermo-economic analysis and dynamic simulation of a novel layout of a renewable energy community for an existing residential district in Italy, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energy Conversion and Management, 2024, 313, 118582.

[6]   Semi-stationary and dynamic simulation models: A critical comparison of the energy and economic savings for the energy refurbishment of buildings, F. Calise, F.L. Cappiello, L. Cimmino, M. Vicidomini, Energy, 2024, 300, 131618.

[7]   A Dynamic Analysis of Biomethane Reforming for a Solid Oxide Fuel Cell Operating in a Power-to-Heat System Integrated into a Renewable Energy Community, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energies, 2024, 17(13), 3160.

[8]   Single mixed refrigerant biomethane liquefaction plant integrated with solar energy: Dynamic simulation for the decarbonization of the heavy road transport sector, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Journal of Environmental Management, 2024, 361, 121261.

[9]   Renewable Energy Systems 2023, L. Cimmino, M. Vicidomini, Editorial di Applied Sciences (Switzerland), 2024 14(5), 1918.

[10] A Novel Layout for Combined Heat and Power Production for a Hospital Based on a Solid Oxide Fuel Cell, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energies, 2024, 17(5), 979.

[11] A solar-assisted liquefied biomethane production by anaerobic digestion: Dynamic simulations for harbors, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Renewable and Sustainable Energy Reviews, 2024, 189, 114066.

[12] A comparative thermoeconomic analysis of fourth generation and fifth generation district heating and cooling networks, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energy, 2023, 284, 128561.

[13] Dynamic simulation and thermoeconomic analysis of a power to gas system, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Renewable and Sustainable Energy Reviews, 2023, 187, 113759.

[14] Renewable smart energy network: A thermoeconomic comparison between conventional lithium-ion batteries and reversible solid oxide fuel cells, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Renewable Energy, 2023, 214, pp. 74–95.

[15] Dynamic Modelling and Energy, Economic, and Environmental Analysis of a Greenhouse Supplied by Renewable Sources, F. Calise, F.L. Cappiello, L. Cimmino, M. Vicidomini, Applied Sciences, 2023, 13(11), 6584.

[16] Integration of photovoltaic panels and solar collectors into a plant producing biomethane for the transport sector: Dynamic simulation and case study, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Heliyon, 2023, 9, e14681.

[17] Dynamic Simulation and Thermoeconomic Analysis of a Novel Hybrid Solar System for Biomethane Production by the Organic Fraction of Municipal Wastes, F. Calise, F.L. Cappiello, L. Cimmino, M. Napolitano, M. Vicidomini, Energies, 2023, 16(6), 2716.

[18] Dynamic analysis of the heat theft issue for residential buildings, F. Calise, F.L. Cappiello, L. Cimmino, M. Vicidomini, Energy and Buildings, 2023, 282, 112790.

[19] Thermoeconomic Optimization of a Polygeneration System Based on a Solar-Assisted Desiccant Cooling, Gesteira, L.G.; Uche, J.; Cappiello, F.L.; Cimmino, L. , Sustainability, 2023, 15(2), 1516.

[20] Dynamic analysis and investigation of the thermal transient effects in a CSTR reactor producing biogas, F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energy, 2023, 263, 126010.

[21] Dynamic simulation modelling of reversible solid oxide fuel cells for energy storage purpose, F. Calise, F.L. Cappiello, L. Cimmino, M. Vicidomini, Energy, 2022, 260, 124893.

[22] Optimal design of a 5th generation district heating and cooling network based on seawater heat pumps", F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Energy Conversion and Management, 2022, 267, 115912.

[23] Dynamic modelling and thermoeconomic analysis for the energy refurbishment of the Italian building sector: Case study for the "Superbonus 110 %" funding strategy", F. Calise, F.L. Cappiello, L. Cimmino, M. Dentice d'Accadia, M. Vicidomini, Applied Thermal Engineering, 2022, 213, 118689.

TEACHING METHODS

The course will be delivered through theoretical lectures.

EXAMINATION/EVALUATION CRITERIA

Written exam.

COURSE DETAILS

" FUNDAMENTALS OF APPLIED OPTICS "

SSD IIND-01/F

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: I
COURSE TYPE: ALL CURRICULA

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Carlo Salvatore Greco**
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EMAIL: carlosalvatore.greco@unina.it

TEACHER: **Prof. Gennaro Cardone**
PHONE: 0817682529
EMAIL: gennaro.cardone@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
None

LEARNING GOALS
This course is designed to equip students with a solid foundation in applied optics, focusing on its relevance to diverse fields such as scientific research, solar energy systems and optical measurement techniques.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
The course provides students with fundamental knowledge and methodological tools needed to analyze optical phenomena. Such tools allow the student to understand the wave and geometrical nature of light, comprehend the causal connections underlying reflection, refraction, interference, and diffraction, and reflect critically on their implications in applied contexts such as optical measurements and data transmission.

Applying knowledge and understanding
The course delivers the ability and tools needed to apply optical principles and methods in practical contexts, favoring the ability to use analytical and methodological tools to solve problems related to light propagation, imaging, and optical measurement systems in scientific and industrial settings.

COURSE CONTENT/SYLLABUS
Introduction to optics. Wave types and equation, harmonic wave, complex numbers, harmonic waves as complex number, plane waves, Maxwell equations and electromagnetic waves.
Geometrical optics. Light's interaction with media, Huygens' principle, Fermat's principle, reflection in plane mirrors, refraction through plane surfaces, imaging by an optical system, reflection and refraction at a spherical surface, thin lenses, vergence and refractive power.
Superposition of waves. Superposition principle, superposition of waves with the same frequency, random and coherent sources, standing waves, superposition of waves with different frequencies and phase and group velocities.
Interference of light. Interference of light, two beam interference, Young's double-slit experiment, double-slit interference with virtual sources, interference in dielectric films, fringes of equal thickness and Newton's rings.
Diffraction of light. Fraunhofer diffraction, diffraction from a single slit, beam spreading, rectangular and circular apertures, resolution and double-slit diffraction

READINGS/BIBLIOGRAPHY
Pedrotti, F. L., Pedrotti, L. M., & Pedrotti, L. S. (2017). Introduction to optics. Cambridge university press.

TEACHING METHODS
Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA
Written exam. The examination will consist in the resolution of two numerical exercises.

COURSE DETAILS

" GENERATIVE DESIGN FOR SMART ADDITIVE MANUFACTURING"

SSD IIND-03/B

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: PROF. ANTONIO GLORIA
EMAIL: antonio.gloria@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge of Computer-Aided Design

LEARNING GOALS
The Course deals with the GENERATIVE DESIGN FOR SMART ADDITIVE MANUFACTURING as an advanced strategy to design and develop innovative, sustainable, smart and lightweight products with tailored morphological, mechanical and functional properties, as well as with integrated functionalities. Generative design is used to design complex shapes and optimized forms according to loading conditions, constraints, manufacturing options, cost, mass, environmental impact and other data that may influence the design. Generative design will allow to explore all the solutions in order to find the best option. Artificial intelligence (AI) and machine learning will transform the design process into a sophisticated engineer-computer interaction. The CREAMI and RICREAMI laboratories will be available to the students.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS).

Knowledge and understanding
The student must demonstrate that he/she has achieved an adequate knowledge of strategies towards the Generative Design for Smart Additive Manufacturing with a special emphasis on the following features:
- ✓ Knowledge of the advanced design methodologies.
- ✓ Knowledge of the advanced principles in design and development of innovative, sustainable, smart and lightweight products.
- ✓ Knowledge of the advanced methodologies for the assessment of the functional analysis of additive manufactured products.
- ✓ Knowledge of the biomimetic and bioinspired design.
- ✓ To describe optimization algorithms.
- ✓ To illustrate the main features of generative design and AI-driven process towards the development of novel and alternative design solutions.

Applying knowledge and understanding
At the end of the course the student must demonstrate that he/she has acquired knowledge of strategies towards the Generative Design for Smart Additive Manufacturing and, in particular, the following abilities:
- ✓ Knowledge and planning of the functional design of additive manufactured components of mechanical systems and products by applying advanced principles of bio-inspired and generative design.
- ✓ Knowledge of advanced concepts for the design of smart and sustainable products towards the ecological transition.
- ✓ To implement conventional methodologies and to rewrite/organise novel functional analyses for innovative products, as a consequence of product reimagination from a new standpoint.
- ✓ To solve technical problems related to the simultaneous optimization of several response variables (e.g., mechanical and further functional features).
- ✓ Management and implementation of several algorithms to develop innovative products.

COURSE CONTENT/SYLLABUS
The course contents will cover the following aspects:
- ✓ Advanced Design for Additive Manufacturing and Generative Design in sustainable and smart product design and development.
- ✓ Understanding the influence of roughness, geometrical and dimensioning tolerances, mechanical properties, process parameters on Generative Design for Smart Additive Manufacturing.
- ✓ Functional Analyses, Mechanical and Thermal Measurements to support the product design and development.
- ✓ From Darwin's Theory of Natural Selection to Generative Design.
- ✓ Nature-Inspired Metaheuristic Algorithms and Genetic Algorithms.
- ✓ Generative Design: challenges and innovative design solutions.
- ✓ Generative Design: artificial intelligence (AI) and machine learning to transform the design process into a sophisticated engineer-computer interaction.
- ✓ AI-driven process towards the development of design solutions.
- ✓ Design for Smart Additive Manufacturing of cellular structures, lattice structures, geometrically hybrid lattice structures and solid-lattice hybrid structures.
- ✓ Optimality Criteria and Integrated Design Methods.

- ✓ Bioinspired architectures for sustainable, smart and lightweight products.
- ✓ Examples of design and application - development of smart, lightweight and sustainable structures in automotive and/or aerospace sectors, using a "bio-logic" approach as a logic strategy to design and engineer biologically inspired platforms, devices and systems.
- ✓ Examples of design and application - development of novel energy storage devices.
- ✓ Examples of design and application - development of novel hydrogen storage devices.

READINGS/BIBLIOGRAPHY
Course notes

TEACHING METHODS
Lectures and exercises for practical insight into the theoretical features

EXAMINATION/EVALUATION CRITERIA
Written and/or Oral and/or Project discussion

COURSE DETAILS

" STATISTICAL PROCESS MONITORING OF HIGH-DIMENSIONAL ENGINEERING DATA "

SSD STAT-01/B

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENGINEERING MANAGEMENT, QUALITY AND DATA SCIENCE FOR TECHNOLOGY

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Antonio Lepore**
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TEACHER: **Prof. Christian Capezza**
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EMAIL: christian.capezza@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 6
COURSE DURATION [NUMBER OF HOURS]: 24

PREREQUISITES
None

LEARNING GOALS
Training on the application (illustrated through open-source statistical software environment R and the funcharts R package) 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 to non-statisticians.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

The course provides students with theoretical knowledge and methodological foundations in statistical process monitoring for complex engineering systems. Students will develop a solid understanding of multivariate and functional data analysis, including the rationale behind control charts, latent structure methods, and signal interpretation. This knowledge enables them to elaborate on statistical concepts and translate them into informed, partially original reflections relevant to quality and process control.

Knowledge and understanding
The course equips students with the practical skills and analytical tools required to implement statistical process monitoring techniques using open-source software (R and the funcharts package). By working on real-world datasets and team-based projects, students will learn to select, apply, and adapt appropriate methodologies to detect patterns, anomalies, and trends in high-dimensional data. They will also enhance their ability to interpret results and communicate findings effectively, even to audiences with a limited statistical background.

Applying knowledge and understanding
The course is delivered through a combination of lectures, hands-on coding sessions, and interactive group activities. Lectures cover methodological tools and case studies, while practical sessions involve the use of R for applying statistical techniques to engineering datasets. Students will engage in collaborative project work, promoting peer learning and applied problem-solving. Active participation and continuous feedback are encouraged throughout the course.

COURSE CONTENT/SYLLABUS
Engineering Approach to Modern Process Monitoring and Control*. The multivariate quality-control problem. The Hotelling control chart. Regression adjustment. Interpretation of out-of-control signals. Latent structure methods.*
Beyond multivariate data analysis*. Introduction to functional data analysis. Statistical monitoring of functional data. Engineering examples through the software environment* R*.*

READINGS/BIBLIOGRAPHY
- *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.*

TEACHING METHODS
Lectures, hands-on coding sessions in R, and interactive group project activities.

EXAMINATION/EVALUATION CRITERIA
Oral examination. The final examination will consist of presenting and discussing a data set chosen by the student, on which at least one of the methods presented in the course will be applied.

COURSE DETAILS

" INNOVATION AND ENTREPRENEURSHIP"

SSD IEGE-01/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENGINEERING MANAGEMENT, QUALITY AND DATA SCIENCE FOR TECHNOLOGY

GENERAL INFORMATION – TEACHER REFERENCES

TEACHERS: PROF. PIERLUIGI RIPPA, PROF. SIMONETTA PRIMARIO
EMAIL: pierluigi.rippa@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge of economics and business

LEARNING GOALS
This program on Innovation and Entrepreneurship for PhD students aims to cultivate a mindset oriented toward opportunity, impact, and value creation beyond traditional academic pathways. It empowers participants to approach their research with entrepreneurial curiosity, encouraging them to think innovatively and embrace calculated risk. Through hands-on learning, the program guides them in assessing the real-world potential of their ideas—validating market needs, identifying competitive advantages, and shaping compelling business models.

Ultimately, the goal is to equip PhD students with the tools and confidence to transform research-driven insights into entrepreneurial ventures or innovation-led roles in academia, industry, or policy.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS).

Knowledge and understanding
Students will gain practical knowledge in key areas such as intellectual property protection, startup financing, and resource management, helping them bridge the gap between scientific research and commercial application. Furthermore,

Applying knowledge and understanding
The program sharpens students' ability to communicate complex ideas effectively to diverse audiences, from potential investors to industry partners, through training in pitching and persuasive storytelling.

COURSE CONTENT/SYLLABUS
1. Academic entrepreneurship: explore the role of universities and research institutions in innovation ecosystems. Discuss how academic knowledge can be translated into entrepreneurial ventures, spin-offs, or impactful collaborations.
2. Business model and lean startup: Understand the structure of a business model, with emphasis on the Business Model Canvas and Value Proposition Canvas.
3. Innovation management and intellectual property management: overview of innovation types (product, process, open, disruptive) and how they emerge within or around research environments.
4. Business plan: exploring key the key components of business plan: executive summary, market analysis, go-to-market strategy, team structure, risk analysis, and financial projections.
5. Pitch desk and presentation: what investors and stakeholders want to hear: problem-solution framing, traction, team, and vision.

READINGS/BIBLIOGRAPHY
- *Scientific articles selected by the instructor*
- *Slides and documents*
- *Suggested reading books*

TEACHING METHODS
Lectures, seminars, gaming,

EXAMINATION/EVALUATION CRITERIA
Discussion of a project work

COURSE DETAILS

"MACHINE LEARNING IN VIBRO-ACOUSTICS"

SSD: IIND-01/D

PHD COURSE IN INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

Dr. Alessandro Casaburo
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url: www.docenti.unina.it/alessandro.casaburo

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION: 12 HOURS

PREREQUISITES
Basic knowledge on vibro-acoustics.

LEARNING GOALS
At the end of the course, students will have knowledge of the main machine learning methods, and will be able to implement these methods through the use of the built-in functions in Matlab and Python.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
At the end of the PhD course, the students will have developed a critical understanding of the foundations of machine learning, including both basic and advanced methodologies. The students will possess in-depth knowledge of the main theoretical principles, algorithms, and tools used in the field. Furthermore, they will be able to assess whether machine learning techniques are appropriate for addressing specific research problems in their field, and will have the skills to implement and adapt such techniques accordingly. Although the applications are primarily focused on the vibroacoustic field, the machine learning theory covered in the course is broad and cross-disciplinary. Therefore, students from any scientific background can benefit from the knowledge and methodologies provided.

Applying knowledge and understanding
Students will be able to apply machine learning methods to complex, real-world problems within their research domain. They will be capable of identifying the most appropriate algorithms for specific tasks, generating ad hoc datasets when needed, and performing effective data pre- and post-processing. Moreover, they will be able to select suitable evaluation strategies and integrate data-driven approaches into broader research workflows, demonstrating both methodological awareness and practical competence.

COURSE CONTENT/SYLLABUS
Machine Learning Basics
Learning algorithms: the task T, the performance measure P, the experience E; Capacity, overfitting and underfitting, The No Free Lunch Theorem, regularization ; Hyperparameters, validation sets, cross-validation; Estimators, bias and variance, trading off bias and variance to minimize mean squared error, consistency; Maximum likelihood estimation, conditional log-likelihood and mean squared error, properties of maximum likelihood; Bayesian statistics, MAP estimation; Challenges motivating Deep Learning.
Machine Learning Algorithms
Linear models: linear discriminant analysis (Gaussian discriminant analysis, Naïve-Bayes classifiers), logistic regression (binary and multinomial logistic regression), linear regression (least square linear, ridge, and lasso regression); Nonparametric models: exemplar-based methods (K nearest neighbor, kernel density estimation), kernel methods (Gaussian processes, support vector machines), trees, forests, bagging, and boosting; Beyond supervised learning: dimensionality reduction (principal component analysis, autoencoders), clustering (hierarchical agglomerative clustering, K means clustering); Deep neural networks: multilayer perceptrons and backpropagation, convolutional neural networks, recurrent neural networks.
Applications
The 7 steps of machine learning: data gathering, data preparation, model choice, model training, model evaluation, parameter tuning, prediction; Examples of applications of machine learning in vibroacoustics.

READINGS/BIBLIOGRAPHY
Murphy, K. P. (2022), *Probabilistic Machine Learning: An Introduction*, MIT Press
Murphy, K. P. (2023), *Probabilistic Machine Learning: Advanced Topics*, MIT Press
Raschka, S., Liu Y., Mirjalili, V., (2022) *Machine Learning with PyTorch and Scikit-Learn*, Packt

TEACHING METHODS
Lectures

EXAMINATION/EVALUATION CRITERIA

The exam consists of an oral discussion of a project, presented either as a written report or through slides, in which the student illustrates how they would plan the implementation of machine learning techniques within their own research domain. An application in the vibroacoustic field is not required for this purpose. Group projects are possible.

COURSE DETAILS

"RANDOM EXCITATION AND RESPONSE OF STRUCTURES"

SSD: IIND-01/D

PHD COURSE IN INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

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GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION: 12 HOURS

PREREQUISITES
Basic knowledge on structural dynamics.

LEARNING GOALS
At the end of the course, students will be able to describe random excitation of different natures and develop knowledge of the method for the estimation and interpretation of structural response of different systems.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
At the end of the course, students will have acquired an advanced understanding of structural response due to random excitations, with particular reference to aerospace structures such as fixed- and rotary-wing aircraft, launchers, re-entry vehicles, satellites, space probes, and orbital stations.
Knowledge will be developed through analytical and numerical approaches, in line with the content of the scientific-disciplinary sector.

Applying knowledge and understanding
Students will be able to apply the acquired knowledge to model, simulate, and analyze the dynamic behavior of structures subjected to random loads.
They will develop the capability to integrate theoretical and numerical models with experimental data for the purpose of validating and optimizing structural configurations.

COURSE CONTENT/SYLLABUS
Fundamentals of structural dynamics
Identification of structural dynamic parameters
Dynamic characterization of complex structures
Modeling and analysis of deterministic and stochastic dynamic systems
Description and spectral analysis of random signals
Characterization and modeling of stochastic loads (e.g., turbulence, acoustic excitation, mechanical vibrations)
Structural response to random and transient excitations
Validation and optimization of dynamic models through experimental correlation
Applications to aerospace systems: aircraft, launchers, re-entry vehicles, satellites, and space structures

READINGS/BIBLIOGRAPHY
Ewins, D. J., (2000) Modal Testing: Theory, Practice and Application, 2nd Edition*, Research Studies Press LTD., Baldock, England*
Elishakoff, I., (2017) Probabilistic Methods in the Theory of Structures. Strength of Materials, Random Vibrations, and Random Buckling*, World Scientific*

TEACHING METHODS
Lectures with exercises

EXAMINATION/EVALUATION CRITERIA
The exam consists of an oral discussion of a project, presented either as a written report or through slides. Group projects are possible.

COURSE DETAILS

" RESEARCH METHODOLOGIES FOR COMPLEX SYSTEMS"

SSD IEGE-01/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: I
PHD CURRICULUM: ALL CURRICULA

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Cristina Ponsiglione, Dr Simonetta Primario**
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EMAIL: cristina.ponsiglione@unina.it, simonetta.primario@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

None

LEARNING GOALS
This course is specifically designed for doctoral students in Industrial Engineering who seek to develop methodological awareness and operative capabilities in the analysis of complex systems. Contemporary research increasingly requires approaches capable of capturing the dynamic, nonlinear, and decentralized nature of such systems. Agent-Based Modelling and Simulation (ABM&S) offers a flexible and powerful framework for this purpose.
The course combines theoretical foundations with applied activities in a controlled laboratory setting, enabling students to translate conceptual models into executable simulations. Through exposure to modelling practices and simulation environments, the course supports the integration of ABM&S into the methodological repertoire of student doctoral research.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The course is designed to provide doctoral students with a rigorous methodological foundation for investigating the structure and behavior of complex systems. Rather than offering a purely descriptive overview, it promotes a deep and analytical comprehension of complexity, enabling students to interpret systems characterized by nonlinearity, emergence, and adaptive behavior. Emphasis is placed on ABM&S, which is introduced not only as a modeling technique but as a conceptual framework for reasoning about decentralized, heterogeneous systems. This knowledge forms the basis for critical evaluation of research methodologies and their alignment with real-world complexity in engineering systems.

Applying knowledge and understanding
Through direct engagement with simulation tools and guided project development, students will gain the ability to implement ABM&S autonomously. The learning experience is oriented toward the operationalization of abstract concepts: from defining system components and agent behaviors to managing simulation parameters and interpreting results.
This applied competence will allow students to incorporate simulation practices into their research workflows, whether by developing original models or adapting existing ones to specific investigational needs. At the end of the course, students will be able to recognize and classify complex adaptive systems in different fields. Moreover, the acquired skill set will enhance students' ability to structure computational experiments that respond to realistic research questions with methodological rigor.

COURSE CONTENT/SYLLABUS

1st Lecture: Complexity and Modelling Approaches
– Fundamental characteristics of complex systems
– Overview of modelling paradigms
– Introduction to agent-based approaches

2nd Lecture: Simulation Environment
– Introduction to NetLogo
– Interface navigation, syntax, and functionality
– Exploration of sample models

3rd Lecture: Model Development
– Agent behavior specification and interaction rules

– Model calibration and experimental settings
– Data collection and preliminary interpretation

4th Lecture: Laboratory Work
– Structured development of simulation projects (ODD protocol)
– Model implementation and testing
– Documentation and refinement

READINGS/BIBLIOGRAPHY

The following references constitute a selection of foundational texts and research contributions that support the theoretical and applied components of the course. This list is not exhaustive: additional readings will be discussed and recommended during classroom activities, in accordance with the disciplinary backgrounds and research interests of the enrolled doctoral students.

Core Methodological References
These works provide the theoretical and technical foundations of ABM&S, including its formal description protocols and integration with spatial and social data:

- Wilensky, U., & Rand, W. (2015). *An Introduction to Agent-Based Modeling: Modeling Natural, Social, and Engineered Complex Systems with NetLogo*. MIT Press.
- Grimm, V., Berger, U., Bastiansen, F., et al. (2006). "A standard protocol for describing individual-based and agent-based models." *Ecological Modelling*, 198(1–2), 115–126.
- Grimm, V., et al. (2010). "The ODD protocol: a review and first update." *Ecological Modelling*, 221, 2760–2768.
- Castle, C. J. E., & Crooks, A. T. (2006). *Principles and Concepts of Agent-Based Modelling for Developing Geospatial Simulations*. CASA Working Paper 110, University College London.
- Freeman, L. C., & Skolimowski, H. (1974). "The philosophical foundations of simulation." *Simulation*, 23(6), 157–162.

Selected Research Articles by Course Instructors
The following peer-reviewed publications exemplify applied research conducted by the teaching staff. These studies employ ABM&S in the analysis of complex organizational, technological, and socio-environmental systems, and represent different modelling approaches discussed during the course:

- Ponsiglione, C., Primario, S., & Zollo, G. (2019). *Does natural language perform better than formal systems? Results from a fuzzy agent-based model*. *International Journal of Technology, Policy and Management*, 19(2), 171–195.
- Ponsiglione, C., Cannavacciuolo, L., Primario, S., Quinto, I., & Zollo, G. (2021). *The ambiguity of natural language as resource for organizational design: A computational analysis*. *Journal of Business Research*, 129, 654–665.
- Cozzoni, E., Passavanti, C., Ponsiglione, C., Primario, S., & Rippa, P. (2021). *Interorganizational collaboration in innovation networks: An agent-based model for responsible research and innovation in additive manufacturing*. *Sustainability*, 13(13), 7460.
- Cannavacciuolo, L., Ponsiglione, C., Primario, S., Quinto, I., & Zollo, G. (2024). *Can agent-based modelling support organizational design in a complex environment? The proposal of a computational laboratory*. *Journal of Simulation*, 18(2), 136–153.
- Cannavacciuolo, L., Maione, V., Ponsiglione, C., & Primario, S. (2025). *Agent-based modelling of electric vehicle adoption: A multidimensional perspective assessment*. *Research in Transportation Business & Management*, 61, 101407.

Software and Technical Resources
- NetLogo Model Library and Official Documentation: https://ccl.northwestern.edu/netlogo
- Tutorials, code repositories, and user-contributed models (provided during the course)

TEACHING METHODS

The teaching approach is articulated as follows:

- **Lectures and Discussions** provide the theoretical and methodological framework necessary for understanding the dynamics of complex systems and the principles of ABM&S. These sessions are aimed at fostering analytical reasoning and critical reflection on the use of modelling paradigms in scientific research, with attention to both their potential and inherent limitations.
- **Laboratory Sessions** offer students the opportunity to acquire direct experience with simulation environments. Activities are organized to progressively guide participants through the development, implementation, and analysis of simulation models using NetLogo. Emphasis is placed on practical execution, troubleshooting, and iterative refinement of models under the supervision of the instructors.
- **Project-Based Learning** is central to the application phase of the course. Students work in groups to design and develop a simulation model aligned with their doctoral research themes. This component encourages peer interaction, methodological exchange, and the application of modelling tools to real or research-driven problems. The collaborative nature of the project supports the development of both technical and scientific communication skills.

EXAMINATION/EVALUATION CRITERIA

Assessment is based on the development and presentation of a group project. Students are invited to work collaboratively on a shared project topic, which may reflect individual research areas or common interests identified within the group. The project must be documented using the ODD protocol (Overview, Design concepts, and Details), serving as a structured format for describing the model developed during the course.

The evaluation takes into account the overall quality and coherence of the project content, the clarity of the group presentation, and each student's active participation in both the project development and the class activities.

COURSE DETAILS

" ADVANCES IN SHIP SEAKEEPING "

SSD IIND-01A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Ermina Begovic**
PHONE: 081 7683708
EMAIL:begovic@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge of ship seakeeping.

LEARNING GOALS
At the end of the course, students will be able to describe the nonlinear seakeeping problems and develop knowledge of the method for the estimation and interpretation of structural response of different systems

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
The course provides students with knowledge and understanding of research methods and tools needed to analyze 2nd order seakeeping phenomena. .

Upon completion of this course, PhD students will be able to:
- *Demonstrate a systematic understanding of the theoretical foundations and research methods used in 2nd order seakeeping phenomena.*
- *Critically analyze and evaluate advanced concepts related to the numerical results in simulations of high speed craft seakeeping and 2nd order phenomena.*

Applying knowledge and understanding
Upon completion of this course, PhD students will be able to:
- *Apply advanced simulation methodologies for seakeeping of high speed craft, added resistance and nonlinear roll damping.*
- *Independently develop numerical models for simulation of ship behaviour in rough sea.*

COURSE CONTENT/SYLLABUS
- *Ideal Wave Spectra, Ship Responses on Regular Seaway, Ship responses in Irregular way, Seakeeping Criteria*
- *Definition of High Speed Craft, High Speed Implications in motion equations, vertical acceleration analysis (1 CFU)*
- *Definition of 2nd order seakeeping phenomena -slow drift, added resistance, Calculation methods for Added Resistance (1 CFU)*
- *Roll damping linearization, roll decay analysis, stochastic roll damping determination (1 CFU)*

READINGS/BIBLIOGRAPHY
- *J. N. Newman: Marine Hydrodynamics, 40th anniversary edition. Cambridge, The MIT Press, 2017*
- *O.M. Faltinsen: Sea Loads on Ships and Offshore Structures*
- *Scientific articles*

TEACHING METHODS
The course is delivered in 4 lessons of three hours in which the advanced methodology is explained and the relevant examples from scientific community are shown and discussed. During the third hour the practical example to be developed by the attendee is introduced. The reference literature is discussed together and the report task is defined.

EXAMINATION/EVALUATION CRITERIA
Oral discussion of a project developed by the PhD student..

COURSE DETAILS

" SCALING AND SIMILITUDE FOR STRUCTURAL DYNAMICS AND VIBROACOUSTICS"

SSD IIND-01/D

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Prof. Sergio De Rosa, Dr. Alessandro Casaburo**
PHONE: 081 7683581
EMAIL:sergio.derosa@unina.it ; alessandro.casaburo@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge on structural dynamics and vibroacoustics.

LEARNING GOALS
At the end of the course, students will be able to derive and apply different scaling conditions and laws to scale-up or down structural and vibro-acoustic systems.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
At the end of the course, students will acquire an in-depth understanding of the principles of scaling and similitude in structural dynamics and vibroacoustics. They will understand the theoretical foundations of dimensional analysis, scale factors, scaling laws, and similitude conditions, as well as the related concepts of geometric, dynamic, complete, and distorted similitude.
The course will provide both a physical and mathematical perspective on how to replicate the behavior of complex systems using scaled models, with particular emphasis on structural configurations and loads related to aerospace and, more broadly, transport engineering.
Students will become familiar with the limitations, distortions, and applicability of different similarity approaches.

Applying knowledge and understanding
Students will be able to apply the acquired knowledge to design and analyze scaled experimental models that accurately reproduce the dynamic and acoustic response of full-scale structures. They will gain the capability to conduct dimensional analysis, derive scaling laws for structural and vibroacoustic quantities, and evaluate the validity of similitude conditions in practical applications. Through analytical derivations and numerical simulations, students will assess the impact of geometric distortions, boundary conditions, and material properties on the fidelity of the scaled response. These skills will be applied to the design and interpretation of laboratory experiments and predictive models, particularly in the context of aerospace engineering.

COURSE CONTENT/SYLLABUS
Similitude methods: dimensional analysis, STAGE, energy conservation, ASMA, SAMSARA, VOODOO, finite similitude, sensitivity analysis.
Applications of similitude theory: structural and vibroacoustic response of beams, unstiffened and stiffened plates and cylinders, structures subjected to random load (e.g., turbulent boundary layer), complex structures.

READINGS/BIBLIOGRAPHY
Szücs, E., (1980) Similitude and Modelling*, Elsevier, New York*
Casaburo, A., Petrone, G., Franco F., De Rosa, S:, (2019), A Review of Similitude Methods for Structural Engineering*, Applied Mechanics Reviews, 71(3): 030802, DOI: 10.1115/1.4043787*

TEACHING METHODS
Lectures with practical applications.

EXAMINATION/EVALUATION CRITERIA
Students will take an exam with multiple-choice and open-ended questions.

COURSE DETAILS

" DESIGN FOR SOFT ROBOTICS"

SSD IIND-03/B

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: PROF. STANISLAO GRAZIOSO
EMAIL:stanislao.grazioso@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge of dynamics of multi-body systems, continuum mechanics and design of mechatronic systems

LEARNING GOALS
This course covers basic and advanced topics in design, simulation and prototyping of soft robotic systems. The equations of motion of robotic systems including structural flexibility is presented in detail. Simulation models and digital twin are then presented, showcasing applications in multiple domains. From the design perspective, the design of flexible-link manipulators and soft-bodied robots is illustrated. Finally, multiple applications involving soft robots usage are presented.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS).

Knowledge and understanding
The course aims at providing students with the knowledge and methodological tools necessary to design and analyze soft robots. These tools will allow students to properly develop soft robots and their digital twin for multiple applications. Students must demonstrate knowledge and understanding of critical aspects related to the mechanical behavior and design guidelines of robots made of soft bodies and/or joints.

Applying knowledge and understanding
Students must be able to apply the methodological tools learned in the course to the simulation and analysis of a simple soft robotic arm. The course is therefore aimed at transmitting the ability to apply and concretely use the knowledge and acquired methodological tools.

COURSE CONTENT/SYLLABUS
- Introduction of soft robotics
- Design, modeling and simulation (virtual prototyping and testing)
- Prototyping, actuation and experiments (physical prototyping and testing)

READINGS/BIBLIOGRAPHY
Course notes (other)

TEACHING METHODS
Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA
Written and oral.

COURSE DETAILS

" SPECIAL TOPICS IN AEROSPACE SYSTEMS: SPACE DEBRIS MITIGATION"

SSD IIND-01/E

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: PROF. ALESSIA NOCERINO, GIORGIO ISOLETTA
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GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basic knowledge of satellite orbital and attitude dynamics

LEARNING GOALS
This course covers special topics in aerospace systems with concern to space debris and mitigation techniques. Students will learn classical and advanced sensor systems for ground-based and space-based debris detection, as well as classical and advanced relative navigation technologies for close-proximity operations aimed at debris removal.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS).

Knowledge and understanding
The course aims at providing students with the knowledge and methodological tools necessary to analyze space debris. These tools will allow students to understand connections between space debris and solutions for its detection and removal. Students must demonstrate knowledge and understanding critical aspects related to the design of a system for space debris detection and removal.

Applying knowledge and understanding
Students must be able to apply the methodological tools learned in the course to the detection of space debris and to the development of pose estimation and relative navigation techniques. The course is therefore aimed at transmitting the ability to apply and concretely use the knowledge and acquired methodological tools.

COURSE CONTENT/SYLLABUS
- The problem of space debris and mitigation strategies.
- Sensors for space debris mitigation. Ground based observations. Space based observations for surveillance and proximity operations
- Autonomous Relative Navigation: challenges and techniques. Cooperative and Uncooperative Pose Estimation. Filtering Techniques for Relative State Estimation

READINGS/BIBLIOGRAPHY
Course notes

TEACHING METHODS
Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA
Discussion of a final project

COURSE DETAILS

" SUSTAINABLE AND GREEN FUTURE AIR VEHICLE"

SSD IIND-01/C

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING CURRICULUM

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: Prof. F. Nicolosi, P. Della Vecchia, S. Corcione and V. Cusati
PHONE: 081-7683583
EMAIL: FABRIZIO.NICOLOSI@UNINA.IT

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU:3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
None

LEARNING GOALS
The aims of the course are to provide students with a comprehensive understanding of the sustainability challenges facing the aviation sector, particularly the need to reduce emissions while meeting growing transportation demands. It introduces key enabling technologies such as electrification, hybrid propulsion, and hydrogen-powered systems, and explores innovative aircraft configurations like distributed propulsion and three-lifting surface designs. Students will learn to evaluate performance through both environmental and economic metrics, and apply Multidisciplinary Design and Optimization (MDO) approaches to integrate aerodynamics, propulsion, structures, and systems. The course also aims to prepare students to contribute to the future of sustainable aviation through innovation and research.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
Students will acquire a solid understanding of the current and emerging sustainability challenges in aviation, including technological and design-based approaches to reducing environmental impact. They will be familiar with advanced propulsion technologies, innovative configurations, and performance assessment metrics.
Applying knowledge and understanding
Students will be able to apply concepts of electrification, hydrogen propulsion, and Multidisciplinary Design and Optimization (MDO) to real-world case studies and design problems, integrating knowledge from multiple aerospace disciplines.
Making Judgements
Students will develop the ability to critically evaluate aircraft design solutions by balancing environmental, economic, and performance considerations. They will demonstrate an awareness of the trade-offs involved in complex design decisions.
Communication Skills
Students will be able to effectively communicate technical ideas, sustainability concepts, and design evaluations to both specialist and non-specialist audiences using appropriate terminology and tools.
Learning Skills
Students will develop independent learning skills that allow them to engage with ongoing research, technological innovation, and interdisciplinary developments in sustainable aviation, preparing them for advanced studies or professional roles in the sector.

COURSE CONTENT/SYLLABUS
• Sustainability in Aviation: Addressing the dual challenge of reducing emissions and meeting increasing air transportation demands.
• Enabling Technologies: Exploring electrification, hybrid propulsion systems, hydrogen-powered aircraft. • Innovative Configurations: Investigating unconventional designs like distributed propulsion systems, three-lifting surfaces and advanced rear end designs.
• Performance Metrics: Emphasizing the importance of evaluating environmental and economic (cost) impacts. • Multidisciplinary Design and Optimization (MDO): Integrating aerodynamics, propulsion, structures, and systems engineering to manage design trade-offs.
• Future Readiness: Preparing students to contribute to the aviation industry through innovative design and research for sustainable solutions.

READINGS/BIBLIOGRAPHY
Slides of the course.

TEACHING METHODS
Lectures with slides and applications.

EXAMINATION/EVALUATION CRITERIA
Written with multiple choice answers .

COURSE DETAILS

" TENSOR CALCULUS "

SSD IIND-01/F

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: I
PHD CURRICULUM: ALL CURRICULA

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **Dr. Gerardo Paolillo**
PHONE: 0817683405
EMAIL: gerardo.paolillo@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
None

LEARNING GOALS
The course purpose is to give an informal introduction to tensor calculus and its application in engineering.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
The course provides students with fundamental knowledge and methodological tools needed to analyze physical phenomena using vector and tensor calculus. Such tools allow to understand the mathematical structure underlying physical laws in continuum mechanics and field theories, comprehend the role of coordinate systems and transformation properties and reflect critically on the implications of tensor formulations in engineering applications.

Applying knowledge and understanding
The course provides students with the competence to apply tensor calculus in practical contexts for modeling and solving problems related to stress and strain analysis, fluid motion and field representations in mechanical and aerospace engineering, as well as in data processing involving multi-dimensional quantities.

COURSE CONTENT/SYLLABUS
Brief history of tensor calculus. Scalars, vectors and tensors in Cartesian coordinate systems: algebra of vectors and tensors; higher order tensors; tensor calculus. Vector and tensor algebra in a general coordinate system. The metric tensor, covariant and contravariant components. Covariant differentiation. Tensor calculus in a general coordinate system.

READINGS/BIBLIOGRAPHY
Aris, R. (2012). *Vectors, tensors and the basic equations of fluid mechanics*. Dover Publications.
Borisenko, A. I., & Tarapov, I. E. (1979). *Vector and tensor analysis with applications (R. A. Silverman, Trans.)*. Dover Publications.

TEACHING METHODS
Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA
Written exam. The examination will consist in the resolution of two numerical exercises.

COURSE DETAILS

"THERMAL PROTECTION SYSTEMS FOR HYPERSONIC FLIGHT AND PROPULSION"

SSD: IIND-01/F, IIND-01/G

PHD COURSE IN INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II, III
PHD CURRICULUM: AEROSPACE AND NAVAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

Dr. Anselmo Cecere
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phone: 081-7682296
url: https://www.docenti.unina.it/stefano.mungiguerra

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 3
COURSE DURATION [NUMBER OF HOURS]: 12

PREREQUISITES
Basics of Physics and Thermodynamics. Knowledge of fluid dynamics, chemistry and aerospace propulsion may be useful.

LEARNING GOALS
The course will provide students with knowledge and understanding of thermal management in hypersonic flight and aerospace propulsion. The main technologies for thermal protection systems of high-speed vehicles and rocket engines will be presented, together with the most advanced high-temperature materials. Techniques for ground testing thermal protection systems and materials will be also described.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding
The course provides students with knowledge and basic methodological tools needed to analyze thermal protection solutions for hypersonic flight and aerospace propulsion, with specific focus on the problems of aerodynamic heating. The students will acquire knowledge on different solutions and materials adopted for the different environments, their response to the high heating rate, and will be able to understand how different conditions affect the selection of a proper thermal protection system.

Applying knowledge and understanding
The course provides students with tools and ability to simulate the aerothermal conditions of re-entry phases and preliminarily estimate the thermal loads on the most solicited components. This is turned into the capability of selecting the right materials for thermal protection system for the different space transportation systems used in hypersonic flight.

COURSE CONTENT/SYLLABUS
COURSE CONTENT/SYLLABUS
1. Hypersonic flight and aerothermodynamics (0,5 CFU)
    1.1. Introduction to hypersonic flight
    1.2. Hypersonic Regime
    1.3. High temperature gas effects
2. Aerospace propulsion (0,5 CFU)
    2.1. Introduction to aerospace propulsion
    2.2. Architectures and technologies
    2.3. Thermal management of aerospace propulsion systems
3. Thermal Protection Systems and Materials (1 CFU)
    3.1. Thermal Protection Systems
    3.2. Ceramic Materials
    3.3. Ablative Materials
4. Ground testing of high-temperature materials (1 CFU)
    4.1. Main topics in material testing
    4.2. Plasma Wind Tunnels
    4.3. Materials testing in propulsion environment
5. Final exam

READINGS/BIBLIOGRAPHY
1. R. Monti, G. Zuppardi, Elementi di aerodinamica ipersonica, Liguori Editore, 2012
2. J.D., Jr. Anderson, Hypersonic and High-Temperature Gas Dynamics, Second Edition (AIAA Education).

3. D. Vennemann, Hypersonic test facilities available in Western Europe for aerodynamic/aerothermal and structure/material investigations, Phil. Trans. R. Soc. Lond. A (1999) 357, 2227–2248.
4. D.E. Glass, Hypersonic Materials and Structures, NASA Langley Research Center, Hampton, VA (https://ntrs.nasa.gov/api/citations/20160007098/downloads/20160007098.pdf)
5. G.P. Sutton G.P., O. Biblarz, Rocket Propulsion Elements, John Wiley & Sons Inc
6. T.A. Ward., Aerospace Propulsion Systems, John Wiley & Sons Inc
7. W. Krenkel (Ed), Ceramic Matrix Composites – Fibre Reinforced Ceramics and Their Application, Wyley-VCH Verlag, Weinheim 2008
8. W.G. Fahrenholtz (Ed), E.J. Wuchina (Ed), W.E. Lee (Ed), Y. Zhou (Ed), Ultra-High Temperature Ceramics: Materials for Extreme Environment Applications, Wiley, 2021

EXAMINATION

Written exam. The examination will require the resolution of a numerical exercise.

COURSE DETAILS

"VEHICLE DYNAMICS OUTDOOR TESTING AND MULTI-PHYSICAL MODELLING"

SSD IIND-02/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **PROF. FLAVIO FARRONI, PROF. ANDREA GENOVESE**
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GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: English
CFU:5
COURSE DURATION [NUMBER OF HOURS]: 20

PREREQUISITES

Basic knowledge of Applied mechanics

LEARNING GOALS

Students will understand how to design, execute, and analyze outdoor vehicle dynamics experiments, integrating measurement technologies and real-world constraints. Emphasis is placed on model-experiment correlation, sensor integration, and practical methodologies for vehicle behavior interpretation.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The course provides methodological and theoretical tools to understand vehicle dynamics in real-world conditions and to interpret interactions between vehicle systems and road surface with critical and original insight.

Applying knowledge and understanding

Students will be able to design test setups, acquire and process experimental data, and implement multiphysical models to analyze and predict vehicle behavior under dynamic conditions.

COURSE CONTENT/SYLLABUS

Introduction to Vehicle Dynamics & Multi-Physical Modeling Approach (0.5 CFU)
Automotive Sensors Overview (0.5 CFU)
Metrology and Signal Processing (1.0 CFU)
Tire Mechanics – Theory and Modelling (1.0 CFU)
Vehicle Dynamics – Theory and Modelling (1.0 CFU)
Automotive / Motorsport Multi-Physics KPIs (1.5 CFU)
Outdoor Testing for Models' Validation(0.5 CFU)

READINGS/BIBLIOGRAPHY

Segers, J., Analysis Techniques for Racecar Data Acquisition, SAE
Guiggiani, M., The Science of Vehicle Dynamics, Springer

TEACHING METHODS

The course includes lectures, interactive modeling exercises in MATLAB/Simulink, and critical discussion of case studies. Students are encouraged to engage in group work and peer feedback sessions. Seminars by invited experts may complement the teaching.

EXAMINATION/EVALUATION CRITERIA

Evaluation is based on a project developed individually or in small interdisciplinary teams, focused on modeling and simulating a vehicle dynamics scenario. The final assessment consists of an oral discussion with technical depth and critical reflection.

COURSE DETAILS

"VEHICLE KINEMATICS & DYNAMICS: PHYSICS AND MODELLING"

SSD IIND-02/A

PHD PROGRAMME: INDUSTRIAL ENGINEERING
YEAR OF THE PHD PROGRAMME: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: PROF. ALEKSANDR SAKHNEVYCH, PROF. FRANCESCO TIMPONE
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EMAIL: ale.sak@unina.it francesco.timpone@unina.it

GENERAL INFORMATION ABOUT THE COURSE

TEACHING LANGUAGE: ENGLISH
CFU: 5
COURSE DURATION [NUMBER OF HOURS]: 20

PREREQUISITES
Basic knowledge of applied mechanics

LEARNING GOALS
Students will be able to formulate and analyze the kinematic and dynamic behavior of road vehicles using physics-based models. They will acquire the ability to derive and implement multi-DOF models for ride, handling, and longitudinal dynamics. The course emphasizes critical understanding of assumptions, modeling fidelity, and applicability in simulation, control, and virtual testing contexts.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)
Knowledge and understanding:
The course provides students with fundamental and advanced tools to model and analyze vehicle dynamics phenomena, enabling critical interpretation of physical assumptions and modeling choices, as well as fostering an understanding of their implications on simulation accuracy and real-world applicability.

Applying knowledge and understanding:
The course enables the derivation, implementation, and critical assessment of multi-DOF vehicle models for ride and handling, developing the capability to apply these models in simulation, control system design, and virtual testing scenarios.

COURSE CONTENT/SYLLABUS
Introduction to Vehicle Dynamics & Modeling Philosophy *(0.5 CFU)*
Vehicle Motion and Reference Frames *(0.5 CFU)*
Tire Mechanics *(1.0 CFU)*
Vehicle Handling Dynamics *(1.0 CFU)*
Vehicle Ride Dynamics *(1.0 CFU)*
Tire and Vehicle Models *(1.5 CFU)*
Model Validation, Simulation Tools, and Experimental Testing *(0.5 CFU)*

READINGS/BIBLIOGRAPHY
Pacejka, H., Tire and Vehicle Dynamics, Elsevier
Guiggiani, M., The Science of Vehicle Dynamics, Springer

TEACHING METHODS
The course includes lectures, interactive modeling exercises in MATLAB/Simulink, and critical discussion of case studies. Students are encouraged to engage in group work and peer feedback sessions. Seminars by invited experts may complement the teaching.

EXAMINATION/EVALUATION CRITERIA
Evaluation is based on a project developed individually or in small interdisciplinary teams, focused on modeling and simulating a vehicle dynamics scenario. The final assessment consists of an oral discussion with technical depth and critical reflection.

SCHEDA DELL'INSEGNAMENTO (SI)

"PROGETTAZIONE E COMUNICAZIONE DELLA MISURA"

SSD IIND-07/B

CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE
ANNO DI CORSO: I
TIPO DI CORSO: TUTTI I CURRICULA

INFORMAZIONI GENERALI - DOCENTE

DOCENTE: Prof./Ing. Musto Marilena
TELEFONO: 3496404850
EMAIL: marilena.musto@unina.it

INFORMAZIONI GENERALI - ATTIVITÀ

LINGUA DI EROGAZIONE DELL'INSEGNAMENTO: Italiano
CFU: 4
NUMERO DI ORE: 16

EVENTUALI PREREQUISITI
Nessuno

OBIETTIVI FORMATIVI
L'obiettivo principale è realizzare un percorso che ha come punto di partenza la definizione dei termini fondamentali del linguaggio metrologico, stabilire i requisiti di una misura e del relativo processo di misurazione, comprendere il criterio di scelta di uno strumento di misurazione in base alle adeguate specifiche metrologiche assegnate, valutare l'incertezza di misurazione in qualsiasi contesto ingegneristico.

RISULTATI DI APPRENDIMENTO ATTESI (DESCRITTORI DI DUBLINO)
Il corso mira a far acquisire allo studente competenze operative di alto livello, in grado di trasformare il sapere teorico in attività sperimentali e di progettazione avanzata.

CONOSCENZA E CAPACITÀ DI COMPRENSIONE
Il percorso formativo intende fornire agli studenti le conoscenze e gli strumenti metodologici di base necessari per analizzare i processi di misurazione in qualsiasi ambito ingegneristico. Tali strumenti consentiranno agli studenti di comprendere i fondamenti del linguaggio metrologico, i criteri di scelta degli strumenti di misura e le metodologie per la valutazione dell'incertezza. Lo studente sarà in grado di rielaborare in maniera critica e autonoma i concetti appresi, sviluppando una comprensione approfondita delle problematiche legate alla progettazione e comunicazione della misura.

Capacità di applicare conoscenza e comprensione
Il percorso formativo è orientato a trasmettere le capacità e gli strumenti metodologici e operativi necessari ad applicare concretamente le conoscenze acquisite alla progettazione di un processo di misura. In particolare, lo studente sarà in grado di selezionare e utilizzare strumenti di misura adeguati, condurre analisi statistiche sui dati raccolti, valutare l'incertezza di misura e redigere documentazione tecnica conforme agli standard metrologici. Le competenze acquisite saranno applicabili anche in contesti multidisciplinari e innovativi.

PROGRAMMA-SYLLABUS
Lezione 1 - Introduzione al corso, definizione di misura e delle distribuzioni statistiche di densità di probabilità utilizzate nella valutazione dell'incertezza di misura.
Lezione 2 - Metodi di valutazione dell'incertezza estesa di misura e test statistici qualitativi e quantitativi per l'analisi di distribuzione dei dati di misura.
Lezione 3 - Procedure di taratura di strumenti di misura da laboratorio.
Lezione 4 - Esempi di applicazione del metodo di progettazione della misura.

MATERIALE DIDATTICO
Dispense fornite dal docente

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO-MODULO
Lezioni frontali, esercitazioni in aula.

VERIFICA DI APPRENDIMENTO
Prova scritta sulle competenze acquisite e discussione orale.

SCHEDA DELL'INSEGNAMENTO (SI)

"COME GLI APPROCCI DEL PROJECT MANAGEMENT POSSONO ESSERE UTILIZZATI PER LA PROGRAMMAZIONE, IL MONITORAGGIO E LA VALUTAZIONE DEI PROGETTI DI RICERCA? "

SSD IEGE-01/A

CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE
ANNO DI CORSO: I
CURRICULUM DEL PHD: TUTTI I CURRICULA

INFORMAZIONI GENERALI - DOCENTE

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INFORMAZIONI GENERALI - ATTIVITÀ

LINGUA DI EROGAZIONE DELL'INSEGNAMENTO: ITALIANA
CFU: 4
NUMERO DI ORE: 16

EVENTUALI PREREQUISITI
Nessuno

OBIETTIVI FORMATIVI
Il corso si prefigge di introdurre i Dottorandi alle tematiche della gestione dei progetti attraverso l'illustrazione dei diversi approcci di Project Management e, successivamente, di analizzare, alla luce della letteratura, le peculiarità ed i criteri di classificazione dei progetti di ricerca. Ciò al fine di poter illustrare, nell'ultima parte del corso, l'appropriato utilizzo delle metodologie di Project Management alla luce delle peculiarità e della complessità dei progetti di ricerca

RISULTATI DI APPRENDIMENTO ATTESI (DESCRITTORI DI DUBLINO)

Conoscenza e capacità di comprensione
Il percorso formativo intende fornire ai Dottorandi le conoscenze e gli strumenti metodologici di base necessari per comprendere ed analizzare, nelle sue diverse fasi, il ciclo di vita del progetto.
Le conoscenze di base consentiranno di acquisire adeguata consapevolezza per quanto riguarda il significato del termine progetto, le peculiarità dei progetti di ricerca, i principali criteri per la classificazione dei progetti di ricerca. Per quanto riguarda gli strumenti metodologici, gli Studenti acquisiranno conoscenza con le principali metodologie relative ai diversi processi della fase di programmazione del ciclo di vita del progetto.

Capacità di applicare conoscenza e comprensione
Il percorso formativo è orientato a trasmettere, attraverso esempi, casi di studio ed esercitazioni, le capacità e gli strumenti metodologici e operativi necessari ad applicare concretamente le conoscenze illustrate al punto precedente alla gestione dei progetti di ricerca. In particolare, le capacità di applicare conoscenze e comprensione riguardano:
• la capacità di valutare la complessità del progetto di ricerca e di selezionare, di conseguenza, l'approccio di Project Management più adatto
• la capacità di definizione dello scopo del progetto di ricerca
• la capacità di programmare attività, tempi e costi del progetto di ricerca
• la capacità di gestione dei rischi del progetto di ricerca
• la capacità di monitoraggio in fase di esecuzione del progetto di ricerca

PROGRAMMA-SYLLABUS
• Peculiarità, classificazione e caratteristiche dei progetti di ricerca
• La figura del Principal Investigator e la gestione dei progetti di ricerca
• Gli Stakeholder e la loro gestione nei progetti di ricerca
• I principali approcci al Project Management: approccio Waterfall, approccio Ibrido, approccio Agile
• La scelta dell'approccio di Project Management più adeguato alla gestione del progetto di ricerca, in base alla caratteristiche del progetto
• Casi, esempi, esercitazioni

MATERIALE DIDATTICO
Peculiarità, classificazione e caratteristiche dei progetti di ricerca
• La figura del Principal Investigator e la gestione dei progetti di ricerca
• Gli Stakeholder e la loro gestione nei progetti di ricerca
• I principali approcci al Project Management: approccio Waterfall, approccio Ibrido, approccio Agile
• La scelta dell'approccio di Project Management più adeguato alla gestione del progetto di ricerca, in base alla caratteristiche del progetto
• Casi, esempi, esercitazioni

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO-MODULO

La didattica verrà erogata attraverso lezioni frontali, esercitazioni ed illustrazioni di casi

VERIFICA DI APPRENDIMENTO
- Discussione di un elaborato sviluppato nel corso delle lezioni
- Colloquio orale

SCHEDA DELL'INSEGNAMENTO (SI)

"SOLUZIONI ATTUALI E FUTURE PER UNA PROPULSIONE AUTOMOBILISTICA SOSTENIBILE"

SSD IIND-06/A

CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE
ANNO DI CORSO: II-III
PHD CURRICULUM: ENERGY AND MECHANICAL ENGINEERING

INFORMAZIONI GENERALI - DOCENTE

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INFORMAZIONI GENERALI - ATTIVITÀ

LINGUA DI EROGAZIONE DELL'INSEGNAMENTO: italiano
CFU:3
NUMERO DI ORE:15

EVENTUALI PREREQUISITI
Nessuno

OBIETTIVI FORMATIVI
Il Corso ha l'obiettivo di informare lo studente dei più recenti sviluppi inerenti ai sistemi propulsivi in ambito automobilistico per far fronte alla problematica dell'impatto ambientale. L'insegnamento prevede lo studio di unità endotermiche progettate per limitare le specie inquinanti e climalteranti immesse in ambiente e/o per impiegare combustibili di origine rinnovabile. Inoltre, fornisce i fondamenti riguardanti l'elettrificazione dei sistemi propulsivi e la loro gestione energetica.

RISULTATI DI APPRENDIMENTO ATTESI

Conoscenza e capacità di comprensione

Il percorso formativo intende fornire agli studenti le conoscenze e gli strumenti metodologici di base necessari per analizzare il problema dell'impatto ambientale del trasporto veicolare.
Tali strumenti consentiranno agli studenti di comprendere quali sono le fonti delle specie inquinanti e climalteranti connesse all'utilizzo ed alla produzione del veicolo nel corso del ciclo di vita.

Capacità di applicare conoscenza e comprensione

Il percorso formativo è orientato a favorire la capacità di utilizzare gli strumenti metodologici acquisiti per trovare soluzioni volte alla riduzione della problematica ambientale connessa al trasporto veicolare con particolare riferimento all'utilizzo di combustibili di origine rinnovabile ed all'elettrificazione del sistema propulsivo.

PROGRAMMA-SYLLABUS
Problema delle emissioni inquinanti e climalteranti derivanti dal settore del trasporto su strada
Processo di combustone, parametri caratteristici dello stesso
Strategie di combustione avanzate, combustioni a bassa temperatura
Confronto delle proprietà di combustibili convenzionali e decarbonizzati (idrogeno, ammoniaca) e loro impatto sul processo di combustione e formazione di specie inquinanti
Analisi del ciclo di vita di differenti classi di veicoli: convenzionale, elettrico, ibrido
Classificazione di veicoli ibridi
Confronto consumi veicoli elettrici, ibridi e celle a combustibile

MATERIALE DIDATTICO
Slide del Corso fornite dal docente

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO-MODULO

Lezioni frontali

VERIFICA DI APPRENDIMENTO

Orale

SCHEDA DELL'INSEGNAMENTO (SI)

" CONVERSIONE DI RISORSE ENERGETICHE RINNOVABILI CON MICRO-TURBINE A GAS"

SSD IIND-06/A

CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE
ANNO DI CORSO: II-III
CURRICULUM DEL PHD: ENERGY AND MECHANICAL ENGINEERING

INFORMAZIONI GENERALI - DOCENTE

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INFORMAZIONI GENERALI - ATTIVITÀ

LINGUA DI EROGAZIONE DELL'INSEGNAMENTO: ITALIANO
CFU: 3
NUMERO DI ORE: 12

EVENTUALI PREREQUISITI
Conoscenza di Macchine a Fluido e cicli termodinamici

OBIETTIVI FORMATIVI
Il corso ha l'obiettivo di approfondire lo studio dei sistemi di conversione dell'energia con micro turbine a gas (MGT). Analisi di impianti di impianti ibridi con celle a combustibile/microTG, impianti ibridi campo solare/MTG. con MTG e sistema sottoposto ORC (Organic Rankine Cycle). Utilizzo di combustibili alternativi: miscele con idrogeno, gas di sintesi da biomassa. Studio del sistema con software di simulazione termofluidodinamica e studio della combustione con strumenti di calcolo CFD.

RISULTATI DI APPRENDIMENTO ATTESI (DESCRITTORI DI DUBLINO)

Conoscenza e capacità di comprensione
Lo studente deve dimostrare di conoscere e saper comprendere le problematiche di tipo termodinamico e fluidodinamico riguardanti il funzionamento delle microturbine a gas. Il percorso formativo intende fornire le conoscenze riguardanti l'architettura dell'impianto, il ciclo termodinamico, le caratteristiche operative delle macchine che costituiscono questo tipo di impianto, e i metodi di regolazione.

Capacità di applicare conoscenza e comprensione
Lo studente deve dimostrare di essere in grado di riconoscere il contesto in cui una MGT può essere utilizzata ed integrata con altri sistemi energetici e i vincoli di natura tecnologica legati all'impiego di combustibili alternativi a quelli convenzionali.

PROGRAMMA-SYLLABUS
- Caratteristiche delle MGT
- Analisi di sistemi con MGT
- Regolazione della MGT
- Integrazione della MGT con altri impianti: campo solare, cella a combustibile e ORC
- Combustori e combustione nelle MGT
- Utilizzo di combustibili alternativi da risorse rinnovabili
- Applicazioni di calcolo CFD alle camere di combustione di MGT

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MATERIALE DIDATTICO
Appunti del corso forniti dal docente

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO-MODULO
Lezioni frontali ed esercitazioni.

VERIFICA DI APPRENDIMENTO
La verifica finale consiste in una prova scritta con domande a scelta multipla e a risposta aperta.

SCHEDA DELL'INSEGNAMENTO (SI)

INDOOR ENVIRONMENTAL QUALITY: UN APPROCCIO OLISTICO AL BENESSERE E ALLA SICUREZZA DEGLI AMBIENTI

SSD IIND-07/B

CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE
ANNO DI CORSO: II-III
CURRICULUM DEL PHD: ENERGY AND MECHANICAL ENGINEERING

INFORMAZIONI GENERALI - DOCENTE

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INFORMAZIONI GENERALI - ATTIVITÀ

LINGUA DI EROGAZIONE DELL'INSEGNAMENTO: ITALIANO
CFU: 4
NUMERO DI ORE: 18

EVENTUALI PREREQUISITI
Laurea magistrale in Ingegneria o Architettura

OBIETTIVI FORMATIVI
Il corso mira a fornire gli elementi necessari alla valutazione e alla progettazione degli ambienti interni in un quadro olistico che tenga conto dei quattro aspetti di qualità ambientale intesa come risultante di comfort termico, acustico e visivo e qualità dell'aria, e delle esigenze di sicurezza e produttività.

RISULTATI DI APPRENDIMENTO ATTESI (DESCRITTORI DI DUBLINO)

Conoscenza e capacità di comprensione
Il percorso formativo intende fornire agli studenti le conoscenze e gli strumenti metodologici di base necessari per analizzare le interazioni che sussistono tra ambiente confinato, involucro e ambiente esterno, con riferimento ai differenti contesti in cui le suddette relazioni si possono configurare (benessere o sicurezza). Tali strumenti consentiranno agli studenti di comprendere ed individuare i principali parametri fisici descrittivi delle condizioni microclimatiche e di qualità dell'aria e le rispettive metriche di valutazione.

Capacità di applicare conoscenza e comprensione
Il percorso formativo è orientato a trasmettere le capacità e gli strumenti metodologici e operativi necessari a: i) applicare le metodologie necessarie alla valutazione delle condizioni ambientali; b) favorire la capacità di utilizzare gli strumenti acquisiti sia in fase di progetto che in fase di verifica intervenendo in caso di anomalie; c) mostrare la capacità di implementare, secondo la normativa vigente, i modelli di analisi e di calcolo necessari.

PROGRAMMA-SYLLABUS
Elementi di fisiologia della termoregolazione corporea. Approccio ingegneristico alla valutazione termoigrometrica. Grandezze di riferimento, strumenti e metodi di misura. Valutazione oggettiva (metriche ed indicatori, ambienti severi, aspetti normativi). Valutazione soggettiva. Mezzi di trasporto. Valutazione bioclimatica degli ambienti esterni. Modelli matematici termo-fisiologici. Analisi e discussione di casi di studio.

MATERIALE DIDATTICO
Francesca Romana d'Ambrosio, Luca Piterà. La qualità globale dell'ambiente interno. Milano: Editoriale Delfino, 2014.
Ken Parsons. Human thermal environments. Taylor & Francis, 2014.

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO-MODULO
L'attività didattica consiste in lezioni teoriche ed esercitazioni pratiche sviluppate su software proprietario e open source. Il docente utilizzerà: a) lezioni frontali per circa il 50% delle ore totali; b) esercitazioni ed approfondimenti teorici per circa il 35% delle ore totali; c) prova finale di valutazione per circa il 15% delle ore totali.

VERIFICA DI APPRENDIMENTO
La verifica consiste nello svolgimento di una esercitazione guidata in campo e una prova scritta con domande a risposta multipla.

SCHEDA DELL'INSEGNAMENTO (SI)

"TECNICHE NUMERICHE PER L'ANALISI E IL PROGETTO DELLE TURBINE EOLICHE"

SSD IIND-06/A

CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE
ANNO DI CORSO: II-III
CURRICULUM DEL PHD: ENERGY AND MECHANICAL ENGINEERING

INFORMAZIONI GENERALI - DOCENTE

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INFORMAZIONI GENERALI - ATTIVITÀ

LINGUA DI EROGAZIONE DELL'INSEGNAMENTO: ITALIANO
CFU: 3
NUMERO DI ORE: 12

EVENTUALI PREREQUISITI
Nessuno

OBIETTIVI FORMATIVI
Il corso è finalizzato a fornire i fondamenti delle turbomacchine motrici tipicamente utilizzate per la conversione dell'energia eolica. In particolare, verranno forniti agli studenti moderni e ben consolidati strumenti teorici e pratici per l'analisi e la progettazione di turbine eoliche ad asse orizzontale.

RISULTATI DI APPRENDIMENTO ATTESI (DESCRITTORI DI DUBLINO)

Conoscenza e capacità di comprensione
Lo studente deve dimostrare di conoscere e saper comprendere le principali metodologie per l'analisi delle prestazioni e il progetto fluidodinamico di macchine per la conversione dell'energia eolica.
Il percorso formativo intende fornire agli studenti le conoscenze e gli strumenti metodologici di base necessari per procedere all'analisi delle prestazioni e alla progettazione aerodinamica delle turbine eoliche tramite classici e avanzati strumenti numerici.

Capacità di applicare conoscenza e comprensione
Lo studente deve dimostrare di essere in grado di applicare gli strumenti numerici classici ed avanzati appresi durante il corso alla progettazione aerodinamica e all'analisi delle prestazioni in ambiente computazionale delle macchine per la conversione dell'energia eolica.

PROGRAMMA-SYLLABUS
Rotori aperti e intubati, classificazione e applicazioni, curve caratteristiche.
Blade-Element/Momentum Theory: descrizione ed esempi applicativi.
La simulazione fluidodinamica delle turbine eoliche ad asse orizzontale tramite metodi CFD: disco attuatore e linea portante.

MATERIALE DIDATTICO
Dispense e slides del corso.
Testi consigliati:
- Glauert, H., Airplane propellers, in Aerodynamic theory Vol IV, Division L, 1935, Springer.
- Hansen, M.O.L., Aerodynamics of wind turbines, 2015.
- Manwell, J.F. and McGowan, J.G. and Rogers, A.L., Wind energy explained: theory, design and application, Wiley, 2010.
- Sorensen J.N., General Momentum Theory for Horizontal Axis Wind Turbines, Springer, 2016

MODALITÀ DI SVOLGIMENTO DELL'INSEGNAMENTO-MODULO
Lezioni frontali ed esercitazioni.

VERIFICA DI APPRENDIMENTO
Discussione di elaborato progettuale.