Doctoral Program in Mechatronics and Product Innovation Engineering

A.A 2024-2025

Seminars

PhD Seminars provided by the PhD Office

The PhD Office, in collaboration with other University Offices and external experts, offers PhD students interdisciplinary training courses, seminars, and lessons related to academic world, job market and career development.

Seminars list and details: https://www.unipd.it/en/phd-interdisciplinary-teachings

Python Programming for Data Science and Engineering

Seminar Area: Transversal Skills
Credits: 4 (20 hours)
Instructor: Dr. Stefano Tortora, Department of Information Engineering (DEI), University of Padova
e-mail: stefano.tortora@unipd.it

Aim: Python is an easy-to-learn and powerful high-level language and it is becoming more and more popular for scientific applications such as machine learning, statistics, manipulating and transforming data, but also computer vision and robotics. The first objective of the course is to become familiar with Python syntax, environments and basic libraries. Secondly, the learner will be guided in performing basic inferential data analyses and introduced to the application of common machine learning algorithms.

Topics:
- Introduction to the Python Programming Language
    - What is different in Python?
    - The Python Language Syntax
- Modules and Packages
    - NumPy and SciPy: Numerical and Scientific Python
    - Pandas: Labeled Column-Oriented Data
    - Matplotlib: MATLAB-style scientific visualization
    - Scikit-learn: Basics of Machine Learning in Python

References:
[1] J. VanderPlas, "A Whirlwind Tour of Python", O'Reilly Media Inc. 2016. [Online: https://www.oreilly.com/programming/free/files/a-whirlwind-tour-of-python.pdf]
[2] J. VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data" O'Reilly Media Inc. 2017.
[3] B. Miles, "Begin to Code with Python", Pearson Education, Inc. 2018. [Online: https://aka.ms/BeginCodePython/downloads]
[4] Z. Shaw, "Learn Python the Hard Way", Addison-Wesley. 2014.
[5] A. Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", O'Reilly Media Inc. 2019.

Schedule and room: TBD

Enrollment: add the course to the list of courses you plan to attend using the Course Enrollment Form (requires SSO authentication) and, if you are taking the course for credits, to the Study and Research Plan.
Course requirements: Backgrounds in computing with some object-oriented programming language: C++, Java, MATLAB, etc.
Evaluation: Homework assignments

Data Visualization

Seminar Area: Transversal Skills
Credits: 4 (20 hours)
Instructor: Dr. Matteo Ceccarello, Dept. of Information Engineering, University of Padova.
e-mail: matteo.ceccarello@unipd.it

Aim: Data visualization is a fundamental tool in the researcher's toolbox. Visualizing data allows us to uncover patterns and to understand relationships in the data. Furthermore, visualization can be used to deliver more effectively the results of our analyses.

This course covers topics related to human perception and color theory, to inform our choices in the design of graphics. Furthermore, we will focus on the usage of the Grammar of Graphics to create graphics in a modular way, breaking free from the constraints imposed by the API of commonly used libraries.

We will use ggplot, an implementation of the Grammar of Graphics in the R programming language, but the concepts and techniques we will cover are generally applicable (for instance in a Python environment). A working knowledge of R is therefore not required.

Topics:
- The Grammar of Graphics
- Human perception and color theory
- The ggplot implementation of the Grammar of Graphics
- Case studies: how to visualize data from different perspectives
- Avoiding pitfalls in scientific data visualization
- Beyond basic charts: getting creative with the Grammar of Graphics

References:
[1] Healy K. *Data Visualization, a practical introduction*. Princeton University Press. https://socviz.co [2] Wickham H., Grolemund G. *R for Data Science*. O'Reilly. https://r4ds.had.co.nz/
[3] Ware C., *Visual thinking for design*. Elsevier. 2009
[4] Wickham, H. (2010). *A layered grammar of graphics*. Journal of Computational and Graphical Statistics, 19(1), 3-28
Schedule and room: TBD

Course requirements:
● basic programming notions

Evaluation: Homework assignments and final test.

Statistics for Engineers

Seminar Area: Mathematical and Statitical Methods
Credits: 8 (40 hours)
Instructors: Prof. Luigi Salmaso, Prof. Rosa Arboretti, Prof. Marta Disegna, University of Padova.
e-mail: luigi.salmaso@unipd.it , rosa.arboretti@unipd.it , marta.disegna@unipd.it

Topics:
In this course will be offered an introduction to statistical methods most frequently used for experimentation in Engineering.

The course aims to develop knowledge of the fundamental statistical processes, techniques and ideas used in the collection, presentation, analysis and interpretation of data. develop the ability to understand, interpret, and communicate quantitative results and show how quantitative methods may be used to provide reliable information. develop an understanding of the scope and limitations of quantitative analysis.

The indicative content of the course is as follows: elements of univariate statistical methods, including descriptive statistics, probability and inferential statistics (point estimate, confidence interval and hypothesis tests). linear and non-linear regression models. multivariate data analysis. Design of experiment.

Lectures will cover both theoretical aspects and the analysis of practical problems. The applications will be conducted using MINITAB, licensed to University of Padova, and R/Rstudio, open-source software.

References:
- Stark, P.B., 1997. SticiGui: Statistics Tools for Internet and Classroom Instruction with a Graphical User Interface.
- Montgomery DC, Design and Analysis of Experiments, 2010, Wiley.
  Lattin J, Carroll JD, Green PE, Analyzing Multivariate Data, 2003, Duxbury Applied Series.
- Johnson RA, Wichern DW, Applied Multivariate Statistical Analysis,1998, Prentice Hall. 4th edition. Hollander and Wolfe, Nonparametric Statistical Methods, 2nd edition, 1999, Wiley Series in Probability and Statistics.
- Shumway RH, Stoffer DS, Time Series Analysis and Its Applications (With R Examples), 2nd Edition, 1998, Springer Texts in Statistics, NewYork.
- Everitt, B. S., Landau, S., Leese, M., & Stahl, D. (2011). Cluster analysis (Fifth ed.). Wiley series in probability and statistics: John Wiley & Sons, Ltd.

Evaluation:
Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on the discussion of a case study, preferably drawn from the individual PhD project of one of the group members.

Heuristics for Mathematical Optimization

Seminar Area: Mathematical and Statistical Methods
Credits: 5 (20 hours)
Instructor: Prof. Domenico Salvagnin
e-mail: dominiqs@gmail.com, domenico.salvagnin@unipd.it

Aim: Make the students familiar with the most common mathematical heuristic approaches to solve mathematical/combinatorial optimization problems. This includes general strategies like local search, genetic algorithms and heuristics based on mathematical models.

Topics:
- Mathematical optimization problems (intro).
- Heuristics vs exact methods for optimization (intro).
- General principle of heuristic design (diversification, intensification, randomization).
- Local search-based approaches.
- Genetic/population based approaches.
- The subMIP paradigm.
- Applications to selected combinatorial optimization problems: TSP, QAP, facility location, scheduling.

References:
[1] Gendreau, Potvin "Handbook of Metaheuristics", 2010
[2] Marti, Pardalos, Resende "Handbook of Heuristics", 2018

Schedule and room: TBD

Enrollment: add the course to the list of courses you plan to attend using the Course Enrollment Form (requires SSO authentication) and, if you are taking the course for credits, to the Study and Research Plan.

Course requirements:
- Moderate programming skills (on a language of choice)
- Basics in linear/integer programming.

Evaluation: Final programming project.

Entrepreneurship and Startup

Seminar Area: Soft Skills
Credits: 4 credits (20 hours)

Lecturers:
Prof. Moreno Muffatto, DII, University of Padova, moreno.muffatto@unipd.it Ing.
Francesco Ferrati, DII, University of Padova, francesco.ferrati@unipd.it

Topics:
Entrepreneurship
Technology based startup vs SMEs
Venture creation: different options
The team and the early decisions
Types and characteristics of founders' teams
Founders' decisions and their consequences
From the idea to the market
Innovation: technologies and markets
Market size
Development of the product/service concept
Intellectual Property Rights
The structure of a patent application (description, claims, etc) Getting a patent: the patenting process (step by step) Business Models
Business models case studies
Revenue streams
The financials of a startup
The structures of the financial statements
Evaluation of the value of the company
Funding a startup
New ventures' funding options
How and what investors evaluate
How to present a business idea to investors

References:
- Thomas R. Ittelson (2009), Financial Statements: A Step-by-Step Guide to Understanding and Creating Financial Reports, Career Press.
- Ferrati, F. & Muffatto, M. (2021). «Reviewing Equity Investors' Funding Criteria: A Comprehensive Classification and Research Agenda». Venture Capital, Vol. 23: No. 2, pp. 1-22.
- Noam Wasserman (2013) The Founder's Dilemmas: Anticipating and Avoiding the Pitfalls That Can Sink a Startup, Princeton University Press.

Language: English

Evaluation:
Attendance is required for at least 70% of the lecture hours (i.e. 14 hours).
Final evaluation will be based on the discussion of a case study of a technology-based startup.

Research and Entrepreunership: from scientific papers and IP to startup creation

Seminar Area: Soft Skills
Credits: 3 credits (24 hours)
Lecturers:
Prof. Fabrizio Dughiero, DII, University of Padova, fabrizio.dughiero@unipd.it

Topics:
The course aims to develop PhD candidates' ability to transform an idea, linked to a patent owned by our University, into a business model for a technological startup. Intellectual property protection mechanisms, rights of university employees, private employees and free- lancers. What is a startup, a spin-off and laws and regulations that govern its constitution and development. Funding sources. Intellectual property analysis proposed by the teacher and choice of patents on which to develop the team work.
Choice of the patent to be developed. Analysis of the technology, idea or business model underlying the patent. Setting up the analysis work using «design thinking» techniques. First report about planning of the work to be done. Market and competition analysis. Introduction to the Business Model Canvas and compilation of the main parts of the Canvas. Preparation of a concise and effective draft business plan.
Preparation of the pitch to be presented to investors. Presentation session to other teams of the project work and discussion about strengths and weaknesses of business idea.

References:
- Clayton M. Christensen: «The innovation Dilemma - when new technologies cause great firms to fail» Harvard Business Review Press
- Steve Blank and Bob Dorf: «The startup Owner's Manual - the step by step Guide for building a Great Company -K&S Ranch Inc. Publishers
- Some papers from HBR

Language: English

Evaluation:
Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on the discussion of a case study related to the individual or team project.

Bibliographic resources and research tools for PHD students in Industrial Engineering

Seminar Area: Soft Skills
Credit: 1 credit (8 hours)
Lecturers: Librarians

Topics:
1st Module (4 hours)
Online course: to be attended before the face-to-face module.
- Engineering libraries and their services (local and interlibrary loan, document delivery, bibliographic refer- ence, book purchase proposal. . .)
- GalileoDiscovery as the University of Padova Library Search Tool
- Engineering, Economics, Management databases (BSC, IEEE Xplore, Engineering Village, Reaxys, ACM Digital Library, ASTM Compass, DieselNET, Total Materia, BSOL, SAE Mobilus, Springer Materials)
- Citation databases: Scopus (Elsevier), Web of Science (ISI).
2nd Module (4 hours, in two lessons)
Face-to-face course
- Bibliometric indicators: quality measurements of scientific publication
- Academic publishing and Open Access. Padua Research Archive (PRA/IRIS): the institutional repository for academic research.
- Facilitations for authors, tips on authors' rights
- Open Science and data management. Research Data Unipd, the Institutional repository for the outputs of research. (2 hours)
- Bibliographic citations and citation styles. Reference management: introduction to Zotero. (2 hours)

References:
- Engineering Central Library - University of Padova website:
http://biblioingegneriacentrale.cab .unipd.it/
- University Library System website: https://bibliotecadigitale.cab.unipd.it/en specially about Open Science, Open Access, Open Data, Metrics. . .
https://bibliotecadigitale.cab.unipd.it/en /digital-library/about-publishing
- The Principles of Open Scholarly Infrastructure
https://openscholarlyinfrastructure.org/
- Aliprandi, Simone. Fare open access: la libera diffusione del sapere scientifico nell'era digitale. Ledizioni, 2017.
- Capaccioni, Andrea, et al. Ricerche bibliografiche: banche dati e biblioteche in rete. 2. ed, Maggioli, 2018.
- Turbanti, Simona. Strumenti di misurazione della ricerca: dai database citazionali alle metriche del web. Editrice Bibliografica, 2018.

Evaluation:
Attendance is necessary. Online module is required for attending the face-to-face module. The participation will be confirmed through the execution of a final test.

Academic English Courses for PhD students – A.A. 2024/25

Seminar Area: Soft Skills

Lectures: CLA
Credits: 12 (60 hours)
More details: https://cla.unipd.it/en/language-courses/english-for-phd/

The courses listed on this page are **free** and priority will be given to PhD students of the **40th Cohort** (first year) and to those of the **39th cohort who started their PhD in January/February 2024).**

Purpose of the Courses: to review and develop English language competence in academic speaking and writing contexts with a view to identifying and resolving areas of individual concern. To explore a variety of formal academic speaking situations and more informal academic occasions. Tasks will also focus on raising individual awareness of abilities and on strategies for further developing skills.

Course attendance: over ZOOM.

Each type of course requires a minimum entry level of English. It is not possible to attend a course without having first taken the entry test.

INTRO TO ACADEMIC ENGLISH (30 academic hours course) **– Level:** Not lower than B1. Basic structures of Academic English: nominalization, recognizing sentence structure e.g. the use of noun phrases, recognising tense usage and appropriacy of lexis and register. Argumentation. Focus on pronunciation and conversation in certain contexts (confidence building). Promotion of passive skills to develop understanding and lexis. Addressing typical issues in language and pronunciation which may impede comprehension. Students with a level lower than B1 may be addressed to general english courses (basic courses – A2)

ACADEMIC ENGLISH (30 academic hours course) – **Level:** from B1+ to B2 or higher **–** The courses are divided into upper and lower groups. The same topics are covered in different ways and at different speeds according to the level. **WRITING:** writing emails to academic peers; introduction to writing abstracts, structuring research papers, describing data e.g. from graphs or tables; rhetorical moves, coherence and cohesion, stance. **SPEAKING:** presenting research papers at seminars/conferences, dealing with questions and strategies for interrupting politely, active listening and turn taking.

MINI COURSES on specific topics (10 hour mini courses) – **Level**: from B1+ to B2 or higher (B2+). The same topics are covered in different ways and at different speeds according to the level.

- **ACADEMIC WRITING/ABSTRACT:** Conference abstracts and research article abstracts (exploring the differences between conference and research article abstracts, analysis of structure and language use).
- **ACADEMIC SPEAKING/PRESENTATION:** Aspects of formal/professional vs. informal/friendly language; language for debate and discussion, interaction between the presenter and audience, dealing with questions appropriately; organization of the presentation, signposting language; typical pronunciation issues e.g. key vowel sounds; each student will have the opportunity to give a

presentation with the aim of improving their delivery and pronunciation as well as building confidence.

Duration and dates:
Depending on the Cohort, the 30-hour courses will be held from the end of October to December 2024 (only 39th Cohort) or in January/February 2025 (40th Cohort and 39th) and in the 2nd semester (only 40th Cohort). Mini courses will be held from April to July 2025. Preference will be given to the 8.30-10.30 and 16.30-18.30 time slots when scheduling. When registering, participants can indicate a preference regarding course type and period. The CLA will attempt to satisfy requests but the final decision will also be based on the entry test results and on organisational factors.

More details here: https://cla.unipd.it/en/language-courses/english-for-phd-24-25/

From Researcher to Entrepreneur. How to turn research into business ideas

Seminar Area: Soft Skills
Lectures: Davide Tacconi
Credits: 3 (16 hours)
More details: STEM (PhD)

Topic:
This two-day intensive course is designed to guide PhD students at the University of Padua through a practical and interactive path that will help them transform their research and innovations into concrete business ideas. Through a combination of theory and practice, participants will learn how to generate business ideas, develop business models, build business plans and finally present and defend their ideas in a competitive pitching session.
The course will be divided into two separate modules, each focused on a key aspect of the entrepreneurial process:
1. Generation and validation of ideas; business model of an innovative idea
2. Economic-financial planning of an innovative idea and its presentation

Modality: In person seminar
Room: Aula Magna San Nicola, Vicenza, University of Padova

Date: 28 and 29 November 2024, from 9am to 6pm.

How to write a scientific paper

Seminar Area: Soft skills
Credits: 2 (10 hours)
Instructor: Prof.ssa Battini Daria
Email: daria.battini@unipd.it

Topic:
The creation of a written manuscript for submission to a peer-reviewed scientific journal requires significant effort. This effort can be optimized by following a few straightforward suggestions during the writing and preparation process. By adhering to recommended guidelines and avoiding common mistakes, the submission process can be streamlined, allowing even novice authors to navigate it successfully. The purpose of this invited commentary is to provide practical advice for achieving success when writing and submitting manuscripts.
Some tips to select the right journal to submit the research work will be provided.

Modality: In person seminar

Evaluation: Homework assignment

Collaborative Robotics: towards smart manufacturing

Seminar Area: Industrial Plant and Logistics
Credits: 2 (10 hours)
Instructor: Prof. Maurizio Faccio
e-mail: maurizio.faccio@unipd.it

Topic:
Collaborative robotics is revolutionizing the landscape of smart manufacturing, offering new paradigms for efficient and flexible production systems. This seminar delves into the integration of human-robot collaboration (HRC) within assembly operations, highlighting the advantages of dynamic task allocation and the synergy between robots and human operators. Traditional assembly lines are being redefined by the deployment of collaborative robots (cobots), which work alongside humans to enhance precision, safety, and overall productivity. Key topics will include task allocation models, workspace sharing, and the influence of product characteristics on assembly efficiency. Through case studies, the seminar will explore assembly applications, offering insights into how collaborative robotics is poised to meet the demands of Industry 5.0 by improving both human well-being and production outcomes.

Modality: In-person seminar

Evaluation: Homework assignment

Resilient and inclusive workplaces in the Industry 5.0 era: Advanced methods and smart tools in the manufacturing work environment

Seminar area: Industrial Plant and Logistics
Credits: 2 (10 hours)
Instructor: Dr. Nicola Berti
e-mail: nicola.berti@unipd.it

Topic:
The seminar will cover the transition from Industry 4.0 to Industry 5.0 in the manufacturing sector, examining the main characteristics of the two industrial revolutions and their differences. The seminar focuses on the technological aspect, describing the adoption of sensor-driven Digital Twin systems in operation and logistic applications and how managerial strategies have changed based on the availability of Big Data. PhD candidates will gain insight into practical adoptions and case studies concerning digitization. At the end of the seminar, participants will have an overview of the new technologies and strategies that currently help companies transition toward a more human-centered, resilient, and inclusive work environment.
The seminar will explore the following aspects:
• From Industry 4.0 to Industry 5.0: differences and future challenges.
• Human-centered workplace: Integrating ergonomics and human factors in the workplace design process.
• Technological advancements in human data capture for precise ergonomic assessment: New devices to monitor worker safety.
• Human digital twin: strengths, weaknesses, opportunities, and threats of the system responsible for the assessment of human well-being for the future workforce.

Beginning date: Monday, 18 November 2024, 09:00
End date: Monday, 18 November 2024, 18:00
Modality: In-person seminar
Evaluation:
The assignment will be related to the topics discussed during the seminar. PhD students will be asked to compute a risk assessment of some experimental working conditions, considering the adoption of the latest technology discussed in the seminar.

Application of anyLogistix software for Optimizing Digital Supply Chains

Seminar area: Industrial Plant and Logistics
Credits: 2 (10 hours)
Instructor: Dr. Niloofar Katiraee
e-mail: niloofar.katiraee@unipd.it

Topic:
This seminar will introduce PhD candidates to the use of anyLogistix software for optimizing and simulating supply networks. The seminar will begin by covering the fundamental concepts of supply networks, including common challenges and complexities faced in real-world scenarios. The focus will then shift to how the anyLogistix software enables managers and decision-makers to efficiently design and evaluate these networks. Attendees will gain insights into network optimization, simulation techniques, and performance testing, which are crucial for effective supply chain management. By the end of the seminar, participants will have a understanding of supply network fundamentals and will be able to apply anyLogistix to assess and optimize supply chain designs, enhancing their ability to develop efficient networks in their research or professional practice.

Evaluation:
PhD candidates must attend the entire seminar. During the session, participants will work on a case study using the anyLogistix software. They will optimize and simulate the supply network from the case. To earn credit, participants need to submit their results and analysis from the case study as an assignment.

Production planning and batch sizing in 4.0 evolutive environment: analytic and simulative approaches

Seminar area: Industrial Plant and Logistics
Credits: 1 (5 hours)
Instructor: Prof. Marco Bortolini
e-mail: marco.bortolini3@unibo.it

Topic:
The seminar investigates the production planning and batch sizing problem in modern 4.0 evolutive environments made of the simultaneous presence of standard, modern and advanced parallel production lines/machines having diRerent levels of performance. Starting from traditional models, both analytic and simulative approaches are discussed and practically tested using a field-industry database. The goal is to answer to the tactical questions: "How much to produce, when and using which lines/machines?" subject to feasibility constraints and toward an annual global cost optimality. Attendants are expected to enlarge their methods' toolkit in operations' management by:
• Understanding a model for batch sizing within a multi-line production system;
• Benchmarking the model performance by using simulation;
• Applying knowledge by using a field-industry database to develop a multi-scenario analysis.

MODALITY: Hybrid seminar (open to AIDI - Ph.D. Net)

On the development of data-driven decision support systems for Production and Logistics

Seminar area: Industrial Plant and Logistics
Credits: 2 (10 hours)
Instructor: Dr. Finco Serena
e-mail: serena.finco@unipd.it

Topic:
The course will provide students the knowledge necessary to develop data-driven decision support systems to support decision-makers in their decision process. Students will first learn about data analysis, being able to distinguish between descriptive, predictive, and prescriptive methods. Specifically, students will learn the different characteristics of the three methods, their main uses and how to develop them. The course will then focus on prescriptive methods, and specifically on data-driven decision support systems. Students will learn about different uses of data-driven decision support systems through examples taken both from the literature and from real-cases. Here the students will familiarize with how these data-driven decision support systems can be used, and the focus will be put on decision tree-based decision support system.

This (decision tree-based decision support system) will then be the focus of the last part of the course, where students will move from the theory to the practice. In this part, in fact, students will learn how develop decision tree-based decision support system. Here the students will be asked to use Matlab or Python according to their background.

ASSIGNMENT: Devolpment of a decision tree focused on the research topic of each participant (i.e.: material handling equipment selection, assembly systems, resilience)

MODALITY: In person seminar

Numerical methods for Magnetic Field Computation and Design of electromagnetic Actuators in mechatronics

Seminar area: Mechatronics
Credits: 2 (10 hours)
Instructor: Prof. Giuseppe Chitarin
e-mail: giuseppe.chitarin@unipd.it

Topic:
The seminar will cover the following topics:
examples of electromagnetic devices in mechatronics: electric and magnetic field equations, material properties, magnetic forces
numerical formulation and solution of magnetic field equations, with focus on Finite Element Method (FEM)
Application examples: hands-on lab using FEM software
PhD candidates will understand the basic concepts of numerical modelling of electromagnetic devices, and learn the significance of magnetic constraints, boundary conditions and magnetic loads. By the end of the seminar, participants will be able to set-up a realistic model of an electromagnetic device for the estimation of its electric and mechanical parameters.

Modality: lectures + numerical simulation Lab (5+5 hours, in-person)

Evaluation:
Carry out a numerical FEM simulation concerning a specific topic of the course and discuss the results (2 CFU).

Data-driven Science for Dynamical Systems

Seminar area: Mechatronics
Credits: 2 (10 hours)
Instructor: Dr. Jason Bettega
e-mail: jason.bettega@unipd.it

Topic:
The seminar will deal with some of the common data-driven techniques that are usually considered in the different engineering fields with the goal of achieving useful information from raw measurement data. As a consequence, PhD candidates will gain insights into these data-driven techniques, which can be exploited for system identification, control and analysis of dynamical systems in the time/frequency domain.
In particular, the seminar will cover the following main topics:
1) Fast Fourier Transform and Wavelet transform
2) Gabor transform
3) Dynamic Mode Decomposition
4) Koopman Operator
The methods, that will be discussed during the seminar, will be followed by MATLAB examples. Therefore, by the end of the seminar, participants will gain a comprehensive overview of the mentioned data-driven techniques, allowing them to further enrich their skills in the presence of raw measurement data.

Modality: 10 hours in-person, with hands-on experience through MATLAB software.

Evaluation:
Carry out a presentation or a report concerning a specific topic of the seminar, selected by the participant, which is preferably related to her/his own research topics and interests.

Immersive Technologies and Experiences for Smart Industry

Seminar area: Mechatronics
Credits: 1 (5 hours)
Instructor: Prof. Michele Geronazzo
e-mail: michele.geronazzo@unipd.it

Topic:
The seminar will cover immersive technologies and their applications in smart industrial environments, focusing on the design and development of virtual reality (VR) and augmented reality (AR) systems. PhD candidates will gain insights into key enabling technologies like 3D computer vision, multimodal sensing, and artificial intelligence that allow the creation of highly immersive and interactive experiences. Participants will learn methodologies for integrating visual, auditory, and haptic feedback into unified immersive systems that can enhance human-machine collaboration in industrial settings. By the end of the seminar, attendees will be equipped to develop innovative cyber-physical systems that leverage immersive VR/AR for applications such as teleoperation, maintenance assistance, assembly guidance, and operator training. Critical topics like perception engineering, human factors evaluation, and effective human-centered design for industrial use cases will also be covered. PhD candidates will gain insights through this seminar, enabling them to expand the scope of immersive technology use in smart manufacturing and Industry 5.0.

Modality: 5 hours dual (Hydrid)

Evaluation:
For CFU accreditation:
- Attend the seminar lecture and actively participate in discussions.
- Complete assigned readings.
- Analyze how the seminar topics on immersive technologies and human-centered design could be applied to enhance or extend PhD candidate's current research work.

Basics of CAD modeling and technical drawing: how to read and understand Technical Product Documentation

Lecturer
Prof. Roberto Meneghello/Dr. Mattia Maltauro
Department of Management and Engineering
roberto.meneghello@unipd.it/mattia.maltauro@unipd.it

Topics
1. General introduction to Technical Product Documentation
2. CAD fundamentals: solid, surface and mesh modeling
3. CAD lab with Solidworks: sketching, part and assembly
4. From 3D CAD modeling to technical drawing (2D)
5. Technical drawing types
6. How to Read (H2R) a technical drawing:
    a. Understanding representation issues from 2D to 3D
    b. Interpreting general information
    c. Reading the dimensioning scheme
    d. Converting the specification scheme into functional requirements
7. Application Examples

Timetable
January 2025
February 2025

Hours/Credits
15h/3cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100 Vicenza VI – Room To be defined

Lectures format
Traditional lectures + laboratory experience

Admission
Registration in the Stem website

Examination
To be defined

Thermo-fluid dynamics in 3D printed channels

Lecturer
Prof. Simone Mancin
Department of Management and Engineering
simone.mancin@unipd.it

Topics
Thermo-fluid dynamics of printed channels and systems: controlling most important parameter in the design of efficient 3D printed heat exchangers.

Timetable
February 2025

Hours/Credits
5h/1cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100 Vicenza VI – Room To be defined

Lectures format
Traditional lectures

Admission
Registration in the Moodle website

Examination
To be defined

Material selection in a Critical Raw Materials perspective

Lecturer
Prof. Paolo Ferro
Department of Management and Engineering
paolo.ferro@unipd.it

Topics
1. Critical Row Materials
2. Material selection approach
3. Material selection in a CRM perspective

Timetable
March 2025

Hours/Credits
5h/1cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100 Vicenza VI – Room To be defined

Lectures format
Traditional lectures

Admission
Registration in the Moodle website

Examination
To be defined

Efficiency and Renewable Energy in Building Climatization for a Sustainable Future

Lecturer
Prof. Marco Noro
Department of Management and Engineering
marco.noro@unipd.it

Topics
Buildings are responsible for about 40% of total energy consumption in Europe. For this reason, the reduction of the energy needs of buildings and the use of different energy efficiency and renewable energy technologies for annual climatization are essential to meet the EU goal of climate neutrality by 2050.

The course will introduce the most effective energy efficiency solutions for the future nearly zero energy buildings, covering generation, conversion, and end-use of energy, with emphasis on meeting regional and global energy needs in a sustainable manner. Heat pumps technologies, solar systems (thermal and electric), modern cogeneration technologies, mechanical ventilation systems and efficient thermal storage systems will be presented. A particular focus will be dedicated to hydrogen and fuel cells as possible technologies for the completely future decarbonization of energy systems in buildings climatization.

Timetable
May 2025

Hours/Credits
5h/1cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100 Vicenza VI – Room To be defined

Lectures format
Traditional lectures

Admission
Registration in the Moodle website

Examination
To be defined

How to control functionality in product life-cycle using geometrical specifications

Lecturer
Prof. Gianmaria Concheri/Dr. Mattia Maltauro
Department of Management and Engineering
gianmaria.concheri@unipd.it/mattia.maltauro@unipd.it

Topics
1. General introduction to Geometrical Product Specification
2. Integrated ISO GPS/ASME GD&T methodology fundamentals
3. How to Write (H2W) methodology
4. H2W advanced topics:
    a. Datum System
    b. Dependency/independency principles and envelope requirement
    c. Linear sizes according to ISO 14405-1
    d. Dimensions other than linear sizes (ISO 14405-2) and geometrical tolerances according to ISO 1101
    e. The Boundary Condition concept. MMC and LMC modifiers (with applications)
5. How to Compute (H2C) methodology: Position tolerances assignment
6. H2C advanced topics:
    a. Tolerance stack-up analysis: worst case and statistical approaches
    b. Linear geometric tolerance stack-up analysis
7. Application Examples

Timetable
June 2025

Hours/Credits
10h/2cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100 Vicenza VI – Room To be defined

Lectures format
Traditional lectures

Admission
Registration in the Moodle website

Examination
To be defined

Measurement methods in thermo-fluid dynamics

Lecturer
Prof. Giulia Righetti
Department of Management and Engineering
giulia.righetti@unipd.it

Topics
1. Theory (4 h)
    a. Measurements in thermo-fluid dynamics
    b. Measurement's uncertainty and how to calculate it
    c. Temperature measurements
    d. Flow rate measurements
    e. Pressure measurements
    f. Energy and power measurements
2. Laboratory (4 h)
    a. Thermocouples theory, application and calibration.

Timetable
July 2025

Hours/Credits
5h/1cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100
Vicenza VI – Room To be defined
Dipartimento di Tecnica e Gestione dei Sistemi Industriali, Stradella S. Nicola, 3, 36100
Vicenza VI – Thermotechnics Lab

Lectures format
Traditional lectures + laboratory experience

Admission
Registration in the Moodle website

Examination
The examination consists in the preparation of a technical report concerning the measurements collected during the laboratory activity

Reverse Engineering: from physical world to virtual modeling and rapid prototyping

Lecturer
Prof. Roberto Meneghello
Department of Management and Engineering
roberto.meneghello@unipd.it

Topics
1. General introduction to Reverse Engineering
2. Digitization technologies: 3D scanning in industry, medicine, art
3. Tech. laboratory: how to use 3D scanner technologies
4. Virtual prototyping: classification of CAD system and representation schemes
5. CAD laboratory: how to model from point clouds to mesh, mesh to curve/surface, mesh/surface to solid
6. Application examples of rapid prototyping

Timetable
September 2025

Hours/Credits
10h/2cfu

Location
Nuovo Complesso Universitario di Viale Margherita, Viale Margherita, 87, 36100 Vicenza VI – Room To be defined

Lectures format
Traditional lectures + laboratory experience

Admission
Registration in the Moodle website

Examination
To be defined