Research options available for topic B

Research topics a) and b) offered by every Doctoral Course involved in UNIPhD are frameworks within which every applicant has to present an original research project in collaboration with a Supervisor at the University of Padua.

Potential Supervisors at Unipd have proposed the following detailed research options, which are related to the research topic. They are offered as a guideline and should facilitate your contact with potential Supervisors. Supervisors' e-mail is specified in every research option table. You are welcome to contact them directly.

Note that this research option list is not at all exhaustive and, within the topic you have chosen, you are free to propose a different research project.

Doctoral Course	**INDUSTRIAL ENGINEERING**
Macro-area	Physical Sciences and Engineering
Department name	Department of Industrial Engineering
Webpage	http://www.cdii.dii.unipd.it/en/
Research topic B	**Industrial and environmental energy sustainability** The activities relate to the following topics, dealt with by the members of the board of supervisors: energy conversion systems, sustainable energy sources development, energy storage, energy efficiency of buildings, energy efficiency of industrial processes, energy management and economics, eco-sustainable mobility, circular economy and green chemistry for industry, waste-to-energy, environment monitoring and safeguarding, low environmental impact aeronautical systems for territorial monitoring.
Link to the UNIPhD Call (Academic Year 2022/2023)	https://www.unipd.it/en/uniphd
Latest Update	*12.01.2022*
#Number of available Research Options	*7* *Scroll down to see all the Research Options*

#1 Research Option Description

Doctoral Course	**Industrial Engineering**
Department name	Department of Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Design of electrical drives for additive manufacturing technology
Supervisor	Prof. Luigi Alberti, luigi.alberti@unipd.it
Webpage	https://www.unipd.it/contatti/rubrica?detail=Y&ruolo=1&checkout=cerca&persona=alberti&key=3949D86FB49B0EF3F35AAE0F44D64D10 http://edlab.dii.unipd.it/
Context of the research activity and objectives	Electric drives are among the key elements to steer our future towards a more sustainable development and a decarbonized energy utilization. To further improve their performance, new production technologies must be adopted. Among the others, additive manufacturing (AM) technology is one of the most promising solution. The objective of this research option is to tackle the design of an electrical drive considering AM capabilities since the beginning to exploit innovative possibilities. This requires to completely revisit the development of the electric drive. The consolidated design and optimization techniques so far used and adopted are in fact strictly related to conventional manufacturing technologies. The project will be articulated according to various topics related to the design of electrical motors and drives which may consider, for example, electromagnetic, mechanical, and thermal aspects of the drive. As an additional goal, some real components are expected to be fabricated and tested during the project validating the overall design approach.
Infrastructures	The laboratory of the research group has a surface of about 200 square meters providing facilities for the simulation, analysis, and design of electrical drives. Moreover, 8 test benches of various sizes and ratings are available for experimental validation and test with all the required equipment. About 20 people are involved in the research activities of the lab.
Skills and competencies for the development of the activity	Electrical Engineering. Also Mechanical and Energy Engineering are eligible.
Training offer	Metal Additive Manufacturing Technologies A complete list of the training offered by the PhD course is available here: http://www.cdii.dii.unipd.it/en/corsi-e-seminari/ Other courses can be scheduled based on the candidate profile.
Possible Secondments	Aalto University, School of Electrical Engineering, Espoo, Finland ABB - Research Center Vasteros, Sweden

#2 Research Option Description

Doctoral Course	**Industrial Engineering**
Department name	Department of Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Strategic design of plastic waste recycle chains considering waste-to-energy and chemical recycling technologies
Supervisor	Supervisor: Prof. Fabrizio BEZZO fabrizio.bezzo@unipd.it Other academic staff: Prof. Michele Modesti
Webpage	https://research.dii.unipd.it/capelab
Context of the research activity and objectives	The sustainable management of plastic waste represents a formidable challenge for humanity, with deep economic, environmental, and social impacts. This research project aims at setting up a modelling platform for a quantitative assessment and optimisation of a recycle chain for plastic waste. The multifaceted problem will be tackled via the development of a mathematical programming approach accounting for different sources of plastic waste, intermediate collection and sorting steps, and different technological options for chemical recycle and/or waste-to-energy routes. The model will be used for optimising the overall plastic waste chain in terms of economic performance and environmental impact. A rigorous life cycle assessment (LCA) will be incorporated within the modelling framework providing quantitative metrics. The resulting multi-objective optimisation problem will allow drawing strategic considerations in terms of policies, incentives, and regulations. Finally, the effect of uncertainty will be included in the model by means of a stochastic approach in order to account for limited information related to maturity and performance of new technologies, price fluctuations, and environmental parameters.
Infrastructures	The Computer-Aided Process Engineering Lab (CAPE-Lab) leading this project is equipped with advanced computational facilities and state-of-the-art software for modelling and optimization.
Skills and competencies for the development of the activity	The candidate owns a Master's degree in chemical engineering (or related subjects), with strong skills in modelling and numerics. Experience with modelling/simulation software (e.g. GAMS, gPROMS) and mixed-integer linear programming techniques is a preference.
Training offer	The institution offers specific technical courses (e.g. statistics, optimisation and control, etc.). Furthermore, Italian language courses and dedicated training for research management and exploitation as well as for soft skill development are available.
Possible Secondments	Two secondments are proposed in this project: • An industrial secondment at Eni Versalis (Italy), the largest Italian chemical company (3 months) • An academic secondment at ETH Zurich (Switzerland) to learn and apply LCA techniques in this context (4 months)

#3 Research Option Description

Doctoral Course	**Industrial Engineering**
Department name	Department of Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Analysis and design of electric drives for electric vehicles (e-bike, scooter, automotive, aeronautics)
Supervisor	Prof. Nicola Bianchi, nicola.bianchi@unipd.it (members: Dr. Ludovico Ortobina, Dr. Paolo Gherardo Carlet)
Webpage	https://www.dii.unipd.it/en/edlab http://edlab.dii.unipd.it/
Context of the research activity and objectives	Analysis and design of innovative electrical motors for electric vehicles (mainly synchronous type machines). Analysis and design of new algorithms for the control of electrical motors so as to improve the performance of the vehicles (Model Predictive Control, Observer-based control, Robust control). Experimental tests on small-size machines on the laboratory test-bench to validate the predictions.
Infrastructures	Finite Element software. Simulink-Matlab licenses. Test benches in laboratory using dSpace boards.
Skills and competencies for the development of the activity	Knowledge on synchronous electrical machines. Knowledge on control techiniques. Knowledge on electrical drive control.
Training offer	http://www.cdii.dii.unipd.it/en/corsi/
Possible Secondments	Technical University of Munchen (prof. Kammermann) Aalto, University of Helsinki (prof. Hinkanen) IDM srl, via Feltrina, Montebelluna (TV) FANTIC MOTOR Spa, Via Scattolin 4; Quinto (TV) OffCarr, Via dell'Artigianato 29, Villa del Conte (PD)

#4 Research Option Description

Doctoral Course	Industrial Engineering
Department name	Department of Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Increasing use of pretreated biomass for small scale energy production
Supervisor	Prof. Paolo Canu, paolo.canu@unipd.it
Webpage	https://www.dii.unipd.it/category/ruoli/personale-docente?key=696619BC245141559D9684C7856C5F76 https://research.dii.unipd.it/kinnlab/ https://www.k-inntech.it/it
Context of the research activity and objectives	The largest European companies producing biomass stoves and boiler are in the north-east of Italy. The business is constantly expanding and requires a quantum leap to improve the emissions and efficiency level, introducing a science-based approach to the oldest technology in the world, i.e. burning. The physics and chemistry behind porous solids combustion is still largely empirical or oversimplified, so that the design remains mostly based on experience and intuition. The goal of combined research efforts in the group is a deeper, fundamental understanding of the interplay of thermal and chemical processes involved, aiming to improve both the burners design and the manipulation of the raw biomass, for a smoother, more controllable combustion.
Infrastructures	Fully equipped laboratories with state of the art instruments and real scale stoves and boilers. A network of industrial contacts in the biomass field. All the infrastuctures of a primary University in Italy.
Skills and competencies for the development of the activity	Sound knowledge of thermodynamics, transport processes, and chemical kinetics
Training offer	Course of Combustion taught by the PI A large list of course in the renewable energy area as well as related engineering branches (environmental, chemical, material, mechanical)
Possible Secondments	Possibility of arranging several secondments, e.g. Academic secondment with Graz University of Technology - Institute of Thermal Engineering Industrial secondment in primary companies in the field, within a distance of less than 200 km

#5 Research Option Description

Doctoral Course	**Industrial Engineering**
Department name	Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Hybrid nanocomposites as anticorrosive additives in waterborne paints
Supervisor	Prof. Manuele DABALÀ manuele.dabala@unipd.it Co-supervisor: Prof. Andrea BIFFIS (DISC - University of Padova) Members of research group: Luca PEZZATO
Webpage	https://www.dii.unipd.it/metallurgia
Context of the research activity and objectives	The present proposal is focused on the development of hybrid nanocomposites made out of an organic polymer (commercial or custom made) and a metal-based inorganic component featuring anticorrosive properties, to be employed as key additives in the formulation of waterborne anticorrosive paints. The proposed activity aims at performing an extensive study on the practical potential of this novel approach by involving nontoxic anticorrosive components based on various metals as well as organic polymers of different nature and morphologies. The resulting components will be prepared thanks to a collaboration with the group of Prof. A. Biffis (DiSC, University of Padova), a leading expert in the preparation of organic-inorganic hybrid colloids.
Infrastructures	DII can provide the following research equipment for the project: Surface morphology (SEM, AFM, profilometry,…), Crystallographic structures (XRD) Wear resistance (tribology, hardness, lubrication,…) Corrosion measurements (electrochemical test). Furthermore, Optical properties (UV-Vis-IR spectro) can be analyzed at DISC, Mons University can provide the following research equipment's for the project: Physical chemistry of surfaces (XPS, ToF SIMS, FTIR, µ-RAMAN), Ageing / corrosion (climatic chambers, UV, salt spray chambers), Electrical measurements, Thermo-mechanical properties (TGA, DSC)
Skills and competencies for the development of the activity	The prospect PhD student should have at least a basic know-how in chemistry and electrochemistry. Moreover, a basic knowledge on metal surface characterization techniques is appreciated. Basic knowledge of polymer science is a plus
Training offer	Training offer by the PhD Course in Industrial Engineering, training courses offered by the Italian Association of Metallurgy (AIM) and by the Italian Association of Materials Engineering (AIMAT), Summer and Winter Schools organized by various organizations in Metallurgy and Materials Science
Possible Secondments	1. Materials Science Department, University of Mons (Belgium), Prof. Marie-Georges Olivier (6 months – Academic Institution)

	2. Zetagi Srl - Via Pasubio 41, 26051 Creazzo (VI), Dr. Alessandro Roncolato (3 months – Non academic Istitution)

#6 Research Option Description

Doctoral Course	**Industrial Engineering**
Department name	Department of Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Energy management of hybrid electric vehicles
Supervisor	Roberto LOT, roberto.lot@unipd.it
Webpage	https://research.dii.unipd.it/mmsa/
Context of the research activity and objectives	Transportation is responsible for the 20% of greenhouse gas emission in Europe and 14% worldwide. Electric and hybrid electric vehicles (HEVs) are essential for satisfying the long term ambitions of emission reduction, both for road and industrial vehicles. The main objective of this research is to reduce the fuel consumption of HEVs by designing and implementing new Energy Management (EM) systems that optimally split the power demand between the electric motor and combustion engine. In particular, we will develop more efficient EM systems that: a) PREDICTS the power demand (according to route characteristics, driver style, and environmental conditions) for consistently optimise powertrain usage; a) are ROBUST to the actual operating conditions, such as for example component tolerances, component degradation over time, vehicle payload, external environment and other factors.
Infrastructures	Vehicle Dynamics Lab, Tyre Mechanics Lab
Skills and competencies for the development of the activity	General knowledge of hybrid electric vehicles and energy management systems. Expertise in modelling mechanical systems and designing control algorithms. Proficiency in coding with Matlab/Simulink
Training offer	Courses in: Hybrid Electric Vehicles, Technological Advancements in the Electromobility, Vehicle Dynamics, Internal Combustion Engines, Electric Drives For Automation
Possible Secondments	Imperial College London(UK), Loughborough University (UK), UCL - University College London (UK) Dana Incorporated (Italy)

#7 Research Option Description

Doctoral Course	**Industrial Engineering**
Department name	Department of Industrial Engineering
Research topic B	Industrial and environmental energy sustainability
Research option	Flexible large-scale inherently safer e-SMR
Supervisor	Supervisor: Chiara VIANELLO, chiara.vianello@unipd.it Members of the research group: Paolo MOCELLIN
Webpage	https://www.unipd.it/en/scheda-personale?key=8ADC0A59D077FB4EC8A60DED63CBEA11
Context of the research activity and objectives	In the last few years, more than 70 Mton/yr of H_2 have been produced and used worldwide especially in refining processes, ammonia, and methanol production. It Is expected a rapid increase of the H_2 demand, that would double within the next 10 years. Nowadays, almost 70 % of the H_2 is produced from natural gas or naphta steam reforming (SMR) that involves expensive and polluting fired furnaces. Alternative production routes such as methane cracking and electrically heated reformers are under investigation, as they require less electrons per unit of H_2 produced when compared to electrolysers. In particular, direct electrification of SMR (e-SMR) that involves electric heating has shown ground-breaking improvement compared to the state of the art. Associated plants and infrastructures need to be introduced, operated, and commercialized according to robust safety engineering design and practices. However, safety and integration methodologies need to be developed before electrically heated reactor can be widely integrated within the chemical industry. In this framework, the research activity has different objectives including: • The identification of applicable laws/directives and standards for the design of e-SMR; • The demonstration of the applicability and reliability of traditional risk assessment approaches to emerging new H_2 production plants and related infrastructures; • The identification of risk, safety challenges, and impacts associated with flexible large-scale e-SMR: production modulation based on renewable electricity availability.
Infrastructures	Laboratory for chemical reactors, bench scale electrically heated high temperature and pressure reactor, pilot plant e-SMR, GTL pilot plant
Skills and competencies for the development of the activity	Basics of risk analysis techniques (HazOp, FMEA, Fault Tree Analysis). Basics of engineering of chemical reactions and reactors.

Training offer	Writing science effectively. Seminars on heterogeneous catalysis for energy conversion. Seminars on advanced quantitative risk assessment methodologies.
Possible Secondments	The PhD candidate will be able to access with leading industrial chemistry and chemical engineering groups at TUM (Germany) and Poly Montreal (Canada). The PhD candidate will spend a period in the industry, at SYPOX GmbH i.g.: Engineering and manufacturing of e-SMR.