Call for applications for admission to XXXVIII Cycle of Politecnico di Bari PhD Programmes

Attachment 1

PhD PROGRAMME IN MECHANICAL AND MANAGEMENT ENGINEERING

Project Identification Code (CUP): D93C22000520001; D93D22001330001

XXXVIII CYCLE DOCTORATE PROGRAMME PROFILE	
DEPARTMENT	Department of Mechanics, Mathematics and Management
COORDINATOR	Prof. Giuseppe Casalino (giuseppe.casalino@poliba.it)
PLACES AVAILABLE	21
of which	
Places with Politecnico di Bari grant	4
*Places with **Politecnico di Bari grant reserved for graduates from non-Italian universities***	1
*Places with grant funded by NRRP – as per Ministerial Decree **351/2022*** ***Refer to research topic list below***	3 of which: GRANT N.1 - **Area:** Public Administration; **Topic:** "*Energy flexibility in buildings through the storage and control of latent heat energy*"; GRANT N.2 - **Area:** NRRP; **Topic:** "*AI-model based study on optimization of adhesive viscoelastic surfaces energized by micro vibrations for a new generation of pick-and-place robots*"; GRANT N.3 - Area**:** NRRP; **Topic:** "*GTS (Green-Tribo-Systems)*".
*Places with grant funded by NRRP – as per Ministerial Decree **352/2022*** ***Refer to research topic list below***	7 of which: GRANT N. 4 - **Co-funded by**: Omnigrasp s.r.l..; **Topic: "***TSR-Tribology for Soft Robotics"*; GRANT N. 5 - **Co-funded by**: Magna PT s.p.a.; **Topic: "***Gear Teeth 4.0"*; GRANT N. 6 - **Co-funded by**: BionIT Labs; **Topic: "***Innovative robotic hands for prosthetic purposes: from mechanical design to AI"*; GRANT N. 7 - **Co-funded by**: Centro Combustione Ambiente s.p.a.; **Topic: "***Re-engineering of energy systems with a view to zero carbon emissions"*; GRANT N. 8 - **Co-funded by**: Nuovo Pignone s.r.l..; **Topic: "***Centrifugal pumps for the transfer of hydrogen into a liquid state or derived forms (ammonia, methanol) for the marine industry and its applications";* GRANT N. 9 - **Co-funded by**: Pirelli Tyre S.p.A, Gruppo Pirelli & C.; **Topic:** "*The influence of friction and adhesion on defect propagation in viscoelastic contacts*"; GRANT N. 10 – **Co-funded by:** Punch Torino S.P.A; **Topic:** "Challenges of renewable fuel combustion (hydrogen, ammonia and methanol): injection, turbulent combustion, and emissions".

*Place with **externally** funded grant*	1 **Funded by:** Leonardo s.p.a.; **Topic:** **"***Electric transition: impact on structural architectures for wings and fuselage".*
Places without grant funding	5
ADMISSION REQUIREMENTS *Applicants to the PhD programme in Mechanical and Management Engineering **must hold a second level (specialized) degree:***	➢ Degree diploma awarded by the Italian university system prior to Ministerial Decree 509/99; ➢ Specialist Degree (as per Ministerial Decree 509/99); ➢ Master's Degree (as per Ministerial Decree 270/04); ➢ Degree qualifications awarded by foreign universities officially recognised as equivalent[1].

APPLICATION PROCEDURES	
Please note that the information provided below complements and does not substitute that contained in arts. 2 and 3 of the general Application Call.	
REQUIRED DOCUMENTATION *Candidates must upload the following documentation to their online application. **Failure to do so will result in their exclusion from the selection procedure.***	➢ **A CV** following the layout of the example provided by Politecnico di Bari at https://www.poliba.it/it/dottorati-di-ricerca. *(File to be named "01.CV")*. ➢ **Copy of a current identification document**. Only the following documents will be considered eligible: • ID cards issued by an EU member state; • driving licence issued by an EU member; • in all other cases, a full validity passport (also non-EU citizens). *(File to be named "02.Documento Riconoscimento")*. ➢ **Degree qualification certification for first (Bachelor's) degrees and second (specialization/Master's) degrees (or 5-year Single Cycle degrees)**. **Candidates with qualifications awarded in Italy** must attach the Politecnico form available at https://www.poliba.it/it/dottorati-di-ricerca, specifying: • final degree mark; • a list of all exams taken with their relative marks in both degree courses (or the Single Cycle course); • results of exams taken. *(File to be named "03.Titoli di Laurea")*. **Candidates with a degree qualification awarded by a non-Italian university** must attach the following documents to their application, as issued by the awarding body. This supersedes any form of self-declaration [2]:

[1] *Where a qualification awarded by a foreign university **has not yet been declared equivalent** to an Italian university degree, subject to verification by the administration offices, the Selection Committee will decide upon the eligibility of the foreign qualification in line with current Italian regulations and those of the country of origin, as well as any international treaties or agreements on qualification recognition for further study.*

[2] **N.B.**: These documents must be in Italian, French or English or translated into Italian or English and verified by an official Italian diplomatic or consular representative under the responsibility of the candidate. These should follow the guidelines set out in the document "*PROCEDURES FOR ENTRY, RESIDENCY AND ENROLMENT OF INTERNATIONAL STUDENTS AND THE RESPECTIVE*

	• Degree certificate or diploma showing relative final mark; • Official transcript of exams taken during all university study programmes, showing relative results; • Any other type of document which demonstrates the equivalence of qualifications with those required in this application call (Supplementary Diploma, *Dichiarazione di Valore* (statement of value) issued locally. *(File to be named "03.Titoli di Laurea")*. ➢ **An abstract of the thesis topic for specialist/Master's degree (or five-year Single Cycle degree),** stating the title and name of thesis supervisor(s) (max 3,000 characters). *(File to be named "04.Abstract Tesi")*. ➢ **Candidate thesis for specialist/Master's degree (or five-year Single Cycle degree)** For **graduating students** whose thesis is not yet complete (see art.2), a draft version of the thesis which has been completed up to the time of application; (**N.B.** "draft version" implies a version of the thesis text as completed by the graduating candidate up to the date of application, which, in terms of chapters and pages, allows the Selection Committee to evaluate its relative content and subject area. The abstract is uploaded as a separate file and is not considered as a draft version of the thesis under any circumstances. *(File to be named "05.Tesi")*. ➢ **PhD research** proposal which the candidate intends to develop during the programme, stating the scientific basis of the proposal, its research objectives and the methods to be used. Research proposals and projects are assessed purely for the purposes of admission and are not necessarily those which the candidate will follow during the programme. **Research proposals must use the format available at the following link (title "*ALLEGATO A_FORMAT PROPOSTA DI RICERCA_DRIMEG.doc*":** **https://www.poliba.it/sites/default/files/dottorati/allegato_a_format_proposta_di_ricerca_drimeg_english.docx** **N.B**: Candidates who intend to propose a research project based on the topics set out in Ministerial Decrees 351/2022 and 352/2022 must prepare a proposal in line with one or more of the topics listed below. *(File to be named "06.Proposta di Ricerca")*
OPTIONAL DOCUMENTATION	➢ **A self-certification declaration for any other qualifications** deemed suitable for evaluation which must be signed and dated (following the layout of the example provided at

RECOGNITION OF QUALIFICATIONS, FOR HIGHER EDUCATION COURSES IN ITALY FOR THE ACADEMIC YEAR 2022/23" available at the Ministry link https://www.studiare-in-italia.it/studentistranieri/*"*.

	https://www.poliba.it/it/dottorati-di-ricerca), as per arts.46 and 47 of Presidential Decree n. 445/2000. *(File to be named "07.Dichiarazione altri titoli")*. ➢ **Either one or two letters of reference from teaching staff** who have supervised the candidate throughout their university-level studies. *(Files to be named "08.Lettera presentazione 1", "08. Lettera presentazione 2")*. ➢ **Language certification** demonstrating a knowledge of English which corresponds to at least B2 level. Only those candidates who are non-Italian citizens may attach certification which demonstrates knowledge of the Italian language. *(File to be named "09.Certificazione linguistica 1"; etc)*. ➢ **Any publications** related to activity carried out and shown on the candidate's CV. These must be in either Italian or English or translated into Italian or English on behalf of and under the responsibility of the candidate. In cases of **large publications** unavailable in electronic format or which exceed the number of MB permitted for documents, applicants may submit these separately (in paper format or as a CD or DVD-ROM), together with a detailed explanatory list, by 2 p.m. on the deadline date for applications. All publications submitted on paper or on electronic media must be sent in a sealed envelope, signed along the flap, to the following address: Magnifico Rettore del Politecnico di Bari – Direzione Gestione Risorse e Servizi Istituzional i- Settore Ricerca, Relazioni Internazionali e Post-Lauream - Ufficio Protocollo – Via Amendola 126/B, 70126 BARI (Italy). Envelopes must show the name and surname of the candidate together with the following text: "*Concorso di Ammissione al Corso di Dottorato in…* (name of the PhD programme)". The delivery of the envelope containing publications to Politecnico di Bari – by postal service, private courier or shipping agency – is wholly at the candidate's risk. *(File to be named "10.Pubblicazione 1"; etc)*.
DOCUMENT CHECKLIST	**Required documentation:** ➢ **CV** *(to be named "01.CV")*; ➢ **Copy of a current identification document** *(to be named "02.Documento Riconoscimento")*; ➢ **Degree qualification certification for first (Bachelor's) degrees and second (specialization/Master's) degrees (or 5-year Single Cycle degrees)** *(to be named "03.Titoli di Laurea")*;

	➢ **Abstract of the thesis topic for specialist/Master's degree (or five-year Single Cycle degree)** *(to be named "04.Abstract Tesi"*); ➢ **Candidate thesis for specialist/Master's degree (or five-year Single Cycle degree)** *(to be named "05.Tesi"*); ➢ **PhD research proposal** (*to be named "06.Proposta di Ricerca").* **Optional documentation:** ➢ **Self-certification declaration for any other qualifications** *(to be named "07.Dichiarazione altri titoli"*); ➢ **Either one or two letters of reference from teaching staff** *(to be named "08.Lettera presentazione 1", "08. Lettera presentazione 2"*); ➢ **Language certification** *(to be named "09.Certificazione linguistica 1"; etc*); ➢ **Any publications** *(to be named "10.Pubblicazione 1"; etc).*

ADMISSION EXAMINATION	
1.ASSESSMENT OF QUALIFICATIONS HELD	Assessment of qualifications held (average exam scores, final degree mark, theses, Master's degrees, post-graduate courses, language certification, publications, etc.).
2. ASSESSMENT OF RESEARCH PROPOSAL	
3. INTERVIEW	The interview provides an opportunity for a complete evaluation of the candidate and a verification the applicant's aptitude for research and willingness to undertake experience abroad, as well as areas of research interest.
DATES OF INTERVIEWS	Tuesday 20 Sept 2022; Wednesday 21 Sept 2022; Thursday 22 Sept 2022.

The Examination Board will assess candidates' qualifications and interview with a mark **out of 100** (maximum mark for qualifications 20, research proposal 20 and interview 60).
Candidates awarded less than **10 marks** for the **qualification evaluation** will not be admitted to the research proposal phase of the selection process.
The minimum pass mark for the **evaluation of the research proposal** is **10**.
The minimum pass mark for the **interview is 30**.
The minimum overall pass mark for the selection procedure is 50.
The results of the Board's assessment for qualifications and research proposals will be published on the Esse3 portal in the private area of each candidate. No other direct notification will be sent to the candidates.
At the end of the examination procedure, the Board will carry out an overall assessment and draw up an admission rankings list on the basis of the marks obtained by candidates in each part of the examination.

The assessment criteria for qualifications will be established by each Examination Board.

LIST OF RESEARCH TOPICS FOLLOWS

GRANT N. 1

M.D. 351/2022

Area: Public Administration

Topic: “Energy flexibility in buildings through the storage and control of latent heat energy”

RESEARCH PROPOSAL:

The building air-conditioning sector has long been engaged in the search for technologies capable of providing greater energy efficiency and energy flexibility. Direct electrification and thermal-electric cogeneration are among the most widely pursued approaches to pursue a significant reduction in the environmental impact of building energy demands. However, the seasonality of heat demand, the increasing demand for cooling loads, and the variability and limited capacity of renewable electricity supply, often due to constrained and limited electricity grids represent significant constraints that have slowed the replacement of traditional combustion systems (of natural gas in most buildings). Within this framework, there is a growing focus on building electrification coupled with the use of energy storage or coupling solar energy with thermal storage to reduce a building's energy demand. This is evident in Cluster 5 "Climate, Energy and Mobility" of the Horizon Europe program dedicated to developing solutions for sustainable energy production, use and storage.

With building electrical demand becoming increasingly dynamic and an increasing proportion of intermittent renewable generation from solar PV, often adopted heavily in the urban context, the energy grid faces growing challenges in managing the real-time balance between supply and demand. In this scenario, a smart response to energy demands that can also promote thermal energy storage in order to promote energy demand flexibility is receiving increasing attention. This project focuses on different modes of latent thermal storage using thermal batteries with phase change materials whose operation will be implemented through the use of IoT systems and the networking of different energy production and utilization systems. In fact, energy storage technologies promise more flexible energy demand management, with the understanding that energy-flexible buildings are essential for a reliable and resilient power grid, and for this management must introduce "smart" technologies. In fact, buildings can help the grid improve stability by optimizing flexible loads and promoting thermal storage that does not consider electric batteries. This research proposal will develop systems with phase change materials, both microencapsulated and macroencapsulated, produced from animal and plant wastes, in order to increase the sustainability of the adopted raw materials and promoting circularity of materials between different sectors. The project will also include a strong mathematical formulation to quantify energy flexibility, and therefore both coding and simulation capabilities will be required. It is expected that this project will unveil research opportunities to establish a common definition and performance metrics for energy flexibility in buildings with thermal batteries and then develop energy flexibility systems by coupling air conditioning machines with latent thermal storage. The ultimate goal is the development of value chains for the production and the use of both micro-scale (up to 50 kW) and medium-scale (up to 500 kW) latent thermal storage in urban environments.

The challenge of ecological transition requires the concurrence of transdisciplinary expertise in order to address the various issues of a comprehensive transition in a comprehensive manner. In this case, energy management in the urban environment increasingly requires an understanding of the implications of the growing penetration of renewable energy production and solar energy utilization, which inevitably must be

coupled with energy storage systems capable of operating with automated algorithms to optimize their control. Such storage systems increasingly see latent forms as a preferred solution to reduce volumes and increase energy charge density. This research proposal aims to investigate the possibility of promoting latent thermal storage in coupling with traditional air conditioning systems that could take advantage of the variability of renewable energy sources or underutilization of smart power grids in different periods (thus preferring operation in off-peak periods). This research proposal enables the achievement of some of the goals of the European Green Deal with respect to the challenge of making the economy sustainable by turning climate issues and environmental challenges into opportunities. Through dynamic simulations of the most common types of thermal plants, the optimal size of latent thermal storage, of different geometry and operation, will be evaluated. The project will also be carried out by collaborating with a leading national company present in the region, Thermocold, engaged in the development of innovative air conditioning systems.

The research proposal is consistent with the National Strategy of Intelligent Specialization approved by the European Commission. Specifically, the proposed project falls under the national thematic area "Intelligent and Sustainable Industry, Energy and Environment," which provides for development trajectories based on production processes combined with environmental sustainability and technological innovation. In addition, the proposed research is in line with what is outlined in the NRP's "Climate, Energy, Sustainable Mobility" framework, specifically the focus areas "Climate Change, Mitigation and Adaptation" and "Environmental Energy."

Given the research outlined above, the project appears to be centered on the creation of innovative knowledge with significant scientific, social and economic spillovers on the national territory. In particular, the choice of the research program has favored the formation of an energy management professional profile that can respond to the needs for innovation and competitiveness expressed by the business system on this issue, assimilating specialized technical knowledge inherent to both energy management and the peculiarities of the built heritage.

The project complies with the SNSI and the PNR, and is consistent with L.240/2010 and DM 45/2013 on doctoral programs, given the growing need to foster innovation and interchange between the world of research and the productive world and the contribution of research projects in the areas of innovation (L. 240/2010, art. 24, co. 3 and ss.mm.ii.

The solution proposed in this project promises to promote energy conservation-oriented green recovery as advocated by REACT-EU, which aims to fund interventions aimed at circular economy and energy conservation.

The research proposal involves 6 months of research activities at the School of Water, Energy and Environment (SWEE) at Cranfield University (UK), with whom the proposing faculty member has long-standing collaborations on the optimization of thermodynamic cycles coupled with solar energy storage controlled through automated algorithms.

The research activities will concern the study of ways of identifying homogeneous types of users, modeling the related energy demands, and evaluating algorithms that can predict, also through multidisciplinary approaches, the behavior of hybrid and multi-system type "smart" systems in buildings.

The winning candidate will also be functional in the activities of the Politecnico di Bari unit within the international IEA Annex 37 network "Smart Design and Control of Energy Storage Systems" (2020-2025), in which the proposer participates together with other colleagues from Politecnico. This network involves international meetings every 3 months, generally organized at the project partners' premises.

GRANT N. 2

DRIMEG

M.D. 351/2022

Area: NRRP

Topic: "AI-model based study on optimization of adhesive viscoelastic surfaces energized by micro vibrations for a new generation of pick-and-place robots"

RESEARCH PROPOSAL

Adhesion between macroscopic objects is of fundamental importance in the development of cutting-edge technologies such as soft robots, human-robot interaction, soft manipulators. Recent experimental evidence has shown that micrometric vibrations with frequencies close to one kHz can regulate interfacial adhesion in soft viscoelastic materials. The project aims at deepening our understanding in soft contact mechanics, considering the effect of material properties and micro-vibrations on the detachment force of patterned interfaces.

Theoretical, numerical and experimental work will be promoted during the three years of the PhD Course with collaborations with eminent international Universities and Research Centres. Longstanding collaborations are in place with: Prof. Robert McMeeking from Santa Barbara University (USA), Prof. James Barber from Uni Michigan (USA), Prof. Norbert Hoffmann from the Hamburg University of Technology (Germany), Prof. D. Dini from Imperial College (UK), Prof. Huajian Gao from Singapore University (Singapore), Prof. Li Qunyang from Tsinghua University (China), Prof. David Hills from Oxford University, Prof. Andrei Constantinescu from Ecole Polytechnique (Paris), and possibly others.

During the PhD Course the PhD students will be offered the opportunity to collaborate and join the research group of Prof Hoffmann at Tuhh in Hamburg for an abroad staying of about 1 year (max 1.5 year is paid, longer periods are also possible if the student and the supervisor considers this appropriate). In particularly it is expected that the student will develop there BEM models using GPU computing.

The goal of the project is to design, simulate and test micro-structured interfaces actively excited by appropriately designed micro-vibrations to influence their interfacial properties, particularly adhesion.

The PhD student will work in a stimulating environment and will have the possibility to collaborate with the TriboDynamics Lab, recently founded at the Department of Mechanics Mathematics and Management which has received support from the European Research Council under the call ERC-2021-Starting Grant for 1.5 M€ (https://www-dppi.poliba.it/index.php/en/ercstarting-grant).

GRANT N. 3

DRIMEG

M.D. 351/2022

Area: NRRP

Topic: “GTS (Green-Tribo-Systems)”

RESEARCH PROPOSAL

The position is deals with contact mechanics and lubrication of soft viscoelastic solids. The student will be enrolled at the Department of Mechanics, Mathematics and Management, and will be offered the possibility to spend extensive visiting periods in other European Institutions, including Imperial College London (UK) and AC2T (Austria). Duration is 3 years, main working place is in Bari, Italy and the position is fully funded with a scholarship plus research funds. Your goal will be to simulate a multiscale soft system where different phases (solid, liquid and gases are present). You will study tribology of soft material with applications to bearings, car tyres, sealing industries. The new scientific insight will be used to create novel architectures and select better materials. Your activities will include conducting theoretical and experimental research, writing academic papers, presenting your work at international conferences, writing patents on your inventions and supervising MSc students. Work location will be at the DMMM of Politecnico di Bari. The DMMM has been selected as an excellent department by the Italian Ministry of University and Research. It is a young and dynamic environment with 80 permanent staff members and 20 M€ as annual funding, state of the art facilities for high-performance computing and for characterization of materials and surfaces.

GRANT N. 4

DRIMEG

M.D. 352/2022

Co-funded by: Omnigrasp s.r.l.

Topic: “TSR-Tribology for Soft Robotics”

RESEARCH PROPOSAL

Joint position between the Department of Mechanics, Mathematics and Management (DMMM) of Politecnico di Bari, with top-notch expertise in tribology, and Omnigrasp, a pioneering start-up creating soft grippers with electro-active contacts. Collaboration with EPFL in Switzerland, where the student will spend 6 months visiting.

Duration is 3 years, main working place is in Bari, Italy and the position is fully funded with a scholarship plus research funds.

Your goal will be to create the next generation of dexterous soft grippers that can grasp delicate and flexible objects, having negligible energy consumption and requiring little control. By making use of mechanical intelligence, demanding control tasks (force control, path planning, precise positioning) can be embedded into the gripper’s physical design. You will study tribology of electromechanical systems at the interface between the gripper and the object. The new scientific insight will be used to create novel architectures and select better materials.

You will characterise the new gripper and validate it with Omnigrasp’s industry customers. Your activities will include conducting theoretical and experimental research, writing academic papers, presenting your work at international conferences, writing patents on your inventions and supervising MSc students.

Work location will be at the DMMM of Politecnico di Bari. The DMMM has been selected as an excellent department by the Italian Ministry of University and Research. It is a young and dynamic environment with 80 permanent staff members and 20 M€ as annual funding, state of the art facilities for high-performance computing and for characterization of materials and surfaces.

Omnigrasp is a university spin-off incubated in-between EPFL and Politecnico di Bari. Omnigrasp is also hosted within the DMMM, making it easy for the student to work in-between the two institutions. Omnigrasp received the BRIDGE POC grant from the Swiss National Science Foundations and is currently part of an EU-funded project involving 10 partners from 7 European countries. Collaborations are also in UK, Japan and US. Omnigrasp’s mission is to create soft robots to automate the most difficult automation tasks, with the minimum possible energy consumption and the simplest control.

GRANT N. 5

DRIMEG

M.D. 352/2022

Co-funded by: Magna PT s.p.a.

Topic: “Gear Teeth 4.0”

RESEARCH PROPOSAL

In hybrid transmissions, high revs are reached (> 10.000 rpm). As a result, small deviations in the quality of the gear teeth lead to reliability and noise problems. Wastes could be minimized if the noisy component was identified before the sanding step.

The research will aim to predictively control the micro-geometry of the teeth through an integrated control and continuous monitoring system.

In addition, the grinding wheels are replaced at a predetermined number of cycles. The research will focus on defining an algorithm that, based on the quality of the gears being machined, identifies the optimal moment for replacing the grinding wheel. For this purpose and to carry out predictive maintenance, a correlation between the levels of vibrations in the machine, the profile of the tooth and the wear of the grinding wheels will be established.

Artificial Intelligence (AI) will be used to reduce the number of transmissions tested at the end of the assembly line.

Research activities will focus on the following:

- Studying the vibrations transferred from the machines to the piece with specific sensors.
- Characterization of the micro-geometry of the teeth, through the decomposition of the profile into Fourier harmonics to identify the critical ones on the noise performance.
- Correlation between micro-geometry and frequency response of machines and gearing performance.
- Automatic rejection of the piece based on the detected vibrations.
- Identification of the relationship between wear of the grinding wheel and quality performances.
- Development of an AI algorithm to reduce the number of transmissions to be tested, exploiting the information from the processing machine.

GRANT N. 6

DRIMEG

M.D. 352/2022

Co-funded by: BionIT Labs

Topic: “Innovative robotic hands for prosthetic purposes: from mechanical design to AI”

RESEARCH PROPOSAL

The doctoral proposal aims to increase the adoption and dissemination of robotic technologies in the medical field towards Medicine 4.0. The growing interest in this sector is evidenced by the birth of new innovative start-ups from Puglia, including the proponent BionIT Labs (https://bionitlabs.com/) which has already collected numerous international awards (e.g., South Europe Startup Awards (SESA) in the "Best Social Impact Startup" category and the Seal of Excellence for the European Commission's EIC Acceleration Pilot program) and regional and national funding. The PhD proposal will focus on BionIT Labs S.r.l.'s main product, Adam's Hand, a robotic myoelectric hand prosthesis for transradial amputations.

The goal will be to develop, on the one hand, new motion transmission systems by exploiting the principle of under-implementation and on the other, to test new approaches to controlling the prosthesis based on artificial intelligence. The idea is that the study of new under-actuation systems, based for example on differential-type mechanisms, can help a robotic hand to adapt more easily to objects of complex shape, requiring fewer actuators than the number of degrees of freedom of the system. This solution will also make it possible to reduce the complexity of the control algorithm and costs. The further innovative contribution will be linked to the analysis of the recognition of the opening and closing commands of the prosthetic fingers through an algorithm based on machine learning that examines the characteristics of the electromyographic signal (EMG) in real time. Most transradial myoelectric prostheses use a very basic control approach, which however remains predominant since its introduction in the 70s for the control of tridigital myoelectric prostheses: the control takes place with two electromyographic sensors, positioned on the flexor and extensor muscles of the forearm, which read the user's muscle signals to "close" or "open" the prosthetic hand. This control method is not robust, as it is sufficient to position the arm in a different way than the one in which the initial setting of this threshold was made, to make the activation ratio between these two muscles vary, making therefore the device difficult to control by the user.

GRANT N. 7

DRIMEG

M.D. 352/2022

Co-funded by: Centro Combustione Ambiente s.p.a

Topic: "Re-engineering of energy systems with a view to zero carbon emissions"

RESEARCH PROPOSAL

a) Research topic and coherence with the National Smart Specialization Strategy (NSSS) approved by the European Commission

The decarbonization process is envisaged by the Integrated National Energy and Climate Plan 2021-2030 which in January 2020 the MISE sent to the European Commission: in the Plan, Italy provides for the gradual cessation of electricity production from coal by 2025. Pulverized biomass plants can be a powerful tool for the conversion of existing coal plants with minimal investments regarding the partial or complete retrofit of burners and grinding plants. An important contribution to decarbonization can also derive from the use of second-generation biomasses (agricultural, industrial, and organic waste), which do not interfere with food production or land use. Furthermore, with BECCS technologies (BioEnergy with Carbon Capture and Storage) it is even possible to have negative CO2 emissions.

b) Proposed research activity, methodologies, and contents

The re-engineering of coal burners is necessary for the use of biomass due to the high humidity, the low calorific value, the presence of low-melting and/or volatile minerals, and the fibrous structure of the biomass. Critical is the heterogeneity of biomass (complex and variable mixtures of saccharides (cellulose/hemicellulose), lignin and other minor components) whose behavior in boilers is rather difficult to generalize and capture with kinetic models. This re-engineering will be strongly based on CFD as a design tool capable of reducing the "time to market" and the costs associated with experimentation.

c) Degree of innovation of the research proposed for the sector of intervention

The design of a biomass burner using CFD requires a deep knowledge of both the plant engineering aspects and the complex interaction between fluid dynamics and combustion kinetics. The innovation lies in the coupling of the physico-chemical properties of biomass with kinetic submodels.

d) Consistency of the research topic with the disciplinary area of the doctorate and with the composition of the teaching staff

PoliBA and CNR-STEMS already collaborate with CCA in the design of biomass burners by integrating the CFD skills available at PoliBA with those on the fuel characterization by CNR.

e) Technical feasibility of the proposal and implementation timeline

The PhD student will acquire knowledge relating to technical requirements and issues of burner design, as well as modeling and experiments. Experimental and modeling activities include:

- CAD and CFD of biomass burners;
- chemical kinetics;
- pyrolysis and combustion in laboratory reactors (fixed bed, PFR, HGR, DTR);
- chemical analysis, particle size analysis, SEM, ICP, TG-DSC, GC-MS, porosimetry;
- design of burners with very low environmental impact.

f) Synergies with respect to the possible subsequent employment of PhDs (in relation to the world of work).

This project will offer the PhD student the opportunity to develop multiple skills ranging from understanding the kinetic and physico-chemical aspects of reactions, to CFD modeling, up to industrial design, giving it wide employment opportunities.

GRANT N. 8

DRIMEG

M.D. 352/2022

Co-funded by: Nuova Pignone s.r.l.

Topic: "Centrifugal pumps for the transfer of hydrogen into a liquid state or derived forms (ammonia, methanol) for the marine industry and its applications"

RESEARCH PROPOSAL

g) Research topic and coherence with the National Smart Specialization Strategy (NSSS) approved by the European Commission

The decarbonization process is provided for by the Integrated National Energy and Climate Plan 2021-2030 which in January 2020 the MISE sent to the European Commission. For effective decarbonization, the exploitation of renewable energy sources must significantly increase. However, the main ones (solar and wind) are highly unpredictable, and this will cause grid management problems unless effective storage systems are found. This is where hydrogen can play a fundamental role, which, as an energy carrier, could store an enormous amount of energy in chemical form. For the management of effective fueling systems for hydrogen or its derivatives, it is essential to develop all associated technologies including distribution and feeding centrifugal pumps.

h) Proposed research activity, methodologies, and contents

The research activity will be divided into different steps starting from the state of the art; the feasibility study will follow, which will be based on the identification of the machine architecture, the choice of materials and, above all, the integration between pump, motor and control system.

i) Degree of innovation of the research proposed for the sector of intervention

The design of cryogenic centrifugal pumps is highly innovative in consideration of the extreme conditions which the materials are subjected to, and also in terms of hydrogen embrittlement (blistering).

j) Consistency of the research topic with the disciplinary area of the doctorate and with the composition of the teaching staff

Centrifugal pumps fit perfectly within the scope of the specific themes of the PhD in Mechanical and Management Engineering of the Polytechnic of Bari. In addition, the collaboration between the researchers of Nuovo Pignone Tecnologie (Baker Hughes) and many of the members of the teaching staff dates back to more than 10 years ago.

k) Technical feasibility of the proposal and implementation timeline

The candidate will acquire knowledge relating to technical design requirements and issues of centrifugal pumps operating with cryogenic hydrogen or hydrogen derivatives (ammonia, methanol, etc.). Experimental and numerical activities include:

- CAD and CFD of turbomachinery;
- feasibility study;
- definition of the machine architecture;
- identification of materials less subject to hydrogen embrittlement;
- integration of pump, motor, and control system.

l) Synergies with respect to the possible subsequent employment of PhDs (in relation to the world of work).

This project will offer the PhD student the opportunity to develop multiple skills ranging from CFD modeling to industrial design, giving it wide employment opportunities.

GRANT N. 9

DRIMEG

M.D. 352/2022

Co-funded by: Pirelli Tyre S.p.A, Gruppo Pirelli & C

Topic: "The influence of friction and adhesion on defect propagation in viscoelastic contacts"

The main focus of the research activities is the study of the mechanisms behind the nucleation and propagation of defects in viscoelastic materials under the action of periodic loading cycles, with the eventual aim of delivering a tool for qualitative and quantitative estimation of the wear rate in viscoelastic interfaces (i.e., tyre treads) as a function of the nominal working conditions.

During the first part of the Doctorate course, the PhD candidate will focus on the development of theoretical and numerical models describing both the defects nucleation and propagation in viscoelastic materials under generic cyclic loading conditions. Numerical techniques based on Boundary Elements Methods (BEM) will be employed, in order to accurately simulate the tribological and thermal behaviour of the contact interface between tyres and the road surface in the presence of interfacial friction. Since BEM methods rely on the discretization of the sole contact interface, they present a high computational efficiency and numerical accuracy compared to several other conventional methods for numerical simulation of contacts. In this part of the research activity, aiming at catching the real physics behind the start of the defect propagation, the PhD candidate will mostly aim at developing a very accurate simulation of the contact interface, with respect to the whole deformation field. In this regard, he/she will be required to overcome the current state of the art in computational contact mechanics in order to include the effect of interfacial shear stress (in-plane stress) due to frictional interactions between the contacting bodies, and to adapt the contact model to real viscoelastic materials with several relaxation times. The validation of these numerical models will be achieved on specific test cases by direct comparison against conventional simulations performed in Finite Element (FEM) environment. FEM simulations could also be performed in order to investigate the effect of viscoelastic material nonlinearity on the overall response of the contact interface, with specific focus on the defect propagation.

The second part of the Doctorate course will be devoted to the comparison of the innovative theoretical and numerical models just developed with experimental results. The latter will be specifically defined and produced in tight collaboration with the industrial partner Pirelli, also exploiting the visiting period spent by the PhD candidate in the Pirelli facility.

GRANT N. 10

DRIMEG

M.D. 352/2022

Co-funded by: Punch Torino S.P.A;

Topic: “Challenges of renewable fuel combustion (hydrogen, ammonia and methanol): injection, turbulent combustion, and emissions”

RESEARCH PROPOSAL

m) Research topic and coherence with the National Smart Specialization Strategy (NSSS) approved by the European Commission

The exploitation of new renewable fuels (ammonia, methanol, and hydrogen) in internal combustion engines for sectors such as heavy transport, shipping, and energy production, will be decisive for achieving the "Fit for 55" of the EU Green Deal, as well as, at national level, Mission #2, Green Revolution and Ecological Transition, and the M2C2 target: “Renewable Energy, Hydrogen, Network and Sustainable Mobility” of the PNRR. The present research proposal aims to provide a contribution, through modeling activities, to the development of innovative internal combustion engines capable of exploiting these fuels.

n) Proposed research activity, methodologies, and contents

Highly reliable CFD modeling of the injection process, turbulent combustion, and pollutant formation with some of the new renewable fuels (ammonia, methanol, or hydrogen) in internal combustion engines.

o) Degree of innovation of the research proposed for the sector of intervention

The development of reliable predictive simulation models, capable of capturing the peculiar behavior of new renewable fuels (e.g., ammonia, methanol, hydrogen) and innovative combustion systems, is essential to support the growth of a new generation of highly innovative internal combustion engines.

p) Consistency of the research topic with the disciplinary area of the doctorate and with the composition of the teaching staff

This research is in perfect line with the PhD in Mechanical and Management Engineering which, in its teaching staff, sees several teachers of the SSD ING-IND/08, whose declaration includes the study of internal combustion engines.

q) Technical feasibility of the proposal and implementation timeline

The PhD student will initially deal with the state of the art on new fuels in internal combustion engines as well as acquiring skills in highly reliable LES fluid dynamics simulation (5 months poliba - 1 month CERFACS); it will then develop models to be validated in comparison with data available in the literature that serve as benchmarks (6 months CERFACS + 12 poliba); finally, it will apply the acquired experience for the study of cases proposed by the company (6 months PUNCH); the last period will be dedicated to the writing of the

thesis (6 months poliba). In addition, in the first two years the PhD student will follow specific training courses as required by the PhD program.

Synergies with respect to the possible subsequent employment of PhDs (in relation to the world of work).

This project will offer the PhD student the opportunity to develop skills ranging from understanding the kinetic and physico-chemical aspects of reactions, to highly reliable CFD modeling, giving it wide employment opportunities in the automotive/motor sector.