PhD in MECHANICAL ENGINEERING - 30th cycle

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

<table>
<thead>
<tr>
<th>Number of scholarship offered</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>Dipartimento di Meccanica</td>
</tr>
</tbody>
</table>

**Description of the Research Area**

The research area Dynamics and Vibration of Mechanical Systems and Vehicles is organized into five research groups, namely:
- Mechatronics and Robotics (M&R)
- Rotordynamics (RTD)
- Wind Engineering (WND)
- Road Vehicle Dynamics (RVD)
- Railway Dynamics (RWD)

These five groups address general and specific research topics concerning dynamics and vibrations of mechanical systems and vehicles.

For further information:

A selection of possible PhD thesis in Area 1 is listed here below and described in specific attachments; further research topics are also available.

The assignment of a specific PhD topic to candidates admitted to the Programme will be defined at a later stage by the Faculty Commitee, after the beginning of the PhD.

Scholarships allocated in this area may or may not be associated with the PhD topics presented here below:

1. Aeroacoustics: experimental investigation and numerical modelling
2. Condition monitoring methods to reduce the occurrences and impacts of train derailments
3. Development and testing of a diagnostic-prognostic system for the gear-motor of regional train locomotives
4. Development of new coatings in polymeric material (reinforced PTFE, PEEK) for thrust bearings of Hydraulic turbines
5. Influence of smart tires on control strategies for improving vehicle handling and stability
6. Power train and energy management study for electric and hybrid vehicle
7. Railway noise and vibration
8. Fluid-structure interaction
# PhD in MECHANICAL ENGINEERING - 30th cycle

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: AEROACOUSTICS: EXPERIMENTAL INVESTIGATION AND NUMERICAL MODELLING

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<th>Monthly net income of PhD scholarship (max 36 months)</th>
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<tbody>
<tr>
<td>€ 1200.0</td>
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In case of a change of the welfare rates during the three-year period, the amount could be modified.

**Context of the research activity**

The research activity is aimed to develop experimental and numerical methodologies to model the aerodynamic noise emission and propagation. The characterization of the aerodynamic noise sources will allow to consider the aerodynamic contribution in the propagation of the noise in open space in a wide range of different applications: train pass-by noise: the increase in the train speed makes the contribution of the aerodynamic noise coming from the pantograph and roof equipment comparable with the contribution of the other noise sources requiring a verification of the noise barriers efficiency. Tyre-road noise emission: the tyre manufacturer are interested in quantify the contribution of structural borne sound and the contribution of the air-pumping to improve the design of new products noise emission from electrical appliances: Fan & Flow Noise Modeling is required to improve the comfort of household appliances operating in the quiet of the domestic environment.

**Motivation and objectives of the research in this field**

Techniques to identify the noise sources from experimental measurements (in full scale, wind tunnel or anechoic room) and from the numerical simulation of the flow field (CFD approach or Lattice Boltzmann approach) will be investigated.
### Educational objectives

We provide doctoral candidates with high-level scientific training, fostering and refining research and problem solving abilities by focusing on both theoretical and experimental skills. A PhD in Mechanical Engineering will be able to layout, draft and carry on original research, by leading a research group or working in a team.

### Job opportunities

National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.

List of 5 Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

1. Institute of Sound and Vibration Research (ISVR) of the University of Southampton
2. Ecole Central Lyon,
3. RFI (Rete Ferroviaria Italiana)
5. Whirpool Europe

### Composition of the research group

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### Name of the research directors

Bocciolone, Bruni, Cheli, Pennacchi, Resta, Zasso

### Contacts

Supervision of this research topic: Roberto Corradi, Daniele Rocchi
roberto.corradi@polimi.it
daniele.rocchi@polimi.it

For further information
For general information:
silvia.barattieri@polimi.it

### Additional support - Financial aid per PhD student per year (gross amount)

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### Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other informations

#### Educational activities
(purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student per year:
- 2nd year: 1,370 euro per student
- 3rd year: 1,370 euro per student

#### Teaching assistantship:
availability of funding in recognition of supporting teaching activities by the PhD student

There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

#### Computer availability:
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- 2nd year: individual use
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PhD in MECHANICAL ENGINEERING - 30th cycle

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: CONDITION MONITORING METHODS TO REDUCE THE OCCURRENCES AND IMPACTS OF TRAIN DERAILMENTS

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Context of the research activity

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<tr>
<td>Railways are among the safest means to move passengers and freights over a wide range of distances. However, a continuing improvement of safety measures is sought for, in an effort to further reduce the occurrence of failures and accidents. This project will look into different condition monitoring approaches to prevent the occurrence and mitigate the effects of derailments. A focus will be set on investigating the feasibility of a monitoring device to detect early signs of derailment as caused by poor track geometry or by degraded vehicle condition. A second stream of the research will address the structural integrity of main components in the running gear, namely wheels, wheelset axels, bogie frames.</td>
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<td>Different approaches will be considered, including the application of data fusion techniques, also combining on-board and wayside monitoring information. It is expected that the final stage of the project will consist in the design and demonstration (either by laboratory experiments or line tests) of a prototype condition monitoring unit.</td>
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Educational objectives

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Job opportunities

National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.

List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

1. University of Huddersfield
2. Luleå Technical University
3. Bombardier Transportation
4. Lucchini R.S
5. Rete Ferroviaria Italiana
6. Trenitalia

Composition of the research group

10 Full Professors
7 Associated Professors
18 Assistant Professors
23 PhD Students

Name of the research directors

Bocciolone, Bruni, Cheli, Pennacchi, Resta, Zasso

Contacts

Supervision of this research topic: Stefano Bruni, Ferruccio Resta.
stefano.bruni@polimi.it
ferruccio.resta@polimi.it

For further information:

For general information:
silvia.barattieri@polimi.it
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PhD in MECHANICAL ENGINEERING - 30th cycle

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: DEVELOPMENT AND TESTING OF A DIAGNOSTIC-PROGNOSTIC SYSTEM FOR THE GEAR-MOTOR OF REGIONAL TRAIN LOCOMOTIVES

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Context of the research activity

Motivation and objectives of the research in this field

By following two successful projects funded by JRC Transportation aimed at i) defining effective diagnostics of the traction system (TS) of Very High Speed Trains (VHST) and ii) defining the residual life of the bearings of the TS, once a fault has been detected; a new project has started in order to extend the results obtained for VHST to regional trains, in particular on the locomotives E464, which constitutes the back-bone of Italian regional transportation system with about 800 units operating on the network.

In this way, efficient condition based maintenance will be obtained, with savings on costs and with the reduction of the spare parts. The project is compliant with Horizon 2020s objective Societal challenges - Smart, green and integrated transport.

Methods and techniques that will be developed and used to carry out the research

The research will be performed both on a loco E464 operating the line (A) and by realizing a new test rig aimed at performing endurance tests (B) on a large amount of bearings coming from the service in order to have a statistical assessment of the prognostic approach. The bearing will be supplied by Trenitalia disassembling them from E464s gear-motors during overhaul.

The project to be developed consists of:
- Detailed design of sensor installation and data acquisition system (DAQ) on the E464 loco supplied by Trenitalia.
- Purchasing the necessary components and the DAQ.
- Preparing the software for managing the tests on line.
- Installing the DAQ on the loco and perform the tests.
- Detailed design of the test rig for endurance tests.
  Purchasing the necessary components and perform the rig installation.
- Developing of the prognostic model on the basis of the endurance tests results.

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List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

Trenitalia, ABB Vittuone and Bombardier Transportation Vado Ligure. The Ph.D. candidate could spend his period abroad c/o INSA Lyon (F) with prof. Jerome Antoni and Didier Remond, who are working on similar applications for gearboxes and motors.
### Composition of the research group

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### Name of the research directors

Bocciolone, Brun, Cheli, Pennacchi, Resta, Zasso

### Contacts

Supervision of this research topic: Stefano Bruni, Paolo Pennacchi, Steven Chatterton

stefano.bruni@polimi.it  
paolo.pennacchi@polimi.it  
steven.chatterton@polimi.it

For further information:


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silvia.barattieri@polimi.it

### Additional support - Financial aid per PhD student per year (gross amount)

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**Desk availability**:  

1st year: individual use  2nd year: individual use  3rd year: individual use
PhD in MECHANICAL ENGINEERING - 30th cycle

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: DEVELOPMENT OF NEW COATINGS IN POLYMERIC MATERIAL (REINFORCED PTFE, PEEK) FOR THRUST BEARINGS OF HYDRAULIC TURBINES

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Context of the research activity

Motivation and objectives of the research in this field

Oil-film tilting pad thrust bearings are used in supporting the high axial load of the turbine shaft in vertical hydroelectric units. The trend for these applications [1] is to replace the Babbitt metal with a polymeric coating like PTFE or PEEK, improving bearing performances and extending operating conditions. Moreover, polymeric coating are Eco-friendly, avoiding the polluting Babbitt metal and reducing bearing size, thanks to polymeric materials higher normal and shear modulus. This is coherent with Horizon 2020 line Societal challenges: Secure, clean and efficient energy.

Methods and techniques that will be developed and used to carry out the research

Test-rig main characteristics will be: motor power about 90 kW, disk external diameter 1000 mm, tilting pads of about 150×100 mm. Lubricant used: oil, water and salt-water.

The project to be developed consists of:

- Detailed design of the test-rig, under industrial partners specification (Alstom, Eurobearings).
- Purchasing the necessary components. Prepare the software for managing the test-rig.
- Assembling the thrust bearing test-rig and performing all
### Educational objectives

- Performing experimental tests to compare the performances of pads coated by traditional layers of white metal and innovative pads coated by polymeric materials.
- Developing specific software for the calculation of thrust bearings with poly-pads.

### We provide doctoral candidates with high-level scientific training, fostering and refining research and problem solving abilities by focusing on both theoretical and experimental skills. A PhD in Mechanical Engineering will be able to layout, draft and carry on original research, by leading a research group or working in a team.

### Job opportunities

National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.

List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

Test rig already funded by EUROBEARINGS, the Ph.D. candidate could spend his period abroad c/o DTU Lyngby (DK) with prof. Ilmar Santos, who is working on similar applications for wind turbines. Alstom Power is interested to host the student for a certain period in its new global hydropower technology centre in Grenoble.

### Composition of the research group

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Contacts
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steven.chatterton@polimi.it

For further information:

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PhD in MECHANICAL ENGINEERING - 30th cycle

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: FLUID-STRUCTURE INTERACTION

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<tbody>
<tr>
<td>Motivation and objectives of the research in this field</td>
</tr>
<tr>
<td>Reliable numerical models to reproduce the aeroelastic effects on slender structures require a validation against experimental results at full scale or in wind tunnel. The design of lightweight structures is usually based on these numerical models and improvements in these models are important for a correct dimensioning of the structure. The research is aimed to perform specific wind tunnel tests to be used as benchmark and validation of the available models and as a starting point to develop innovative numerical model to deal with aeroelastic interaction.</td>
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<th>Methods and techniques that will be developed and used to carry out the research</th>
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<td>The PhD student who will work in this area will deal with experimental and numerical approaches. The student will be asked to develop and use numerical models both in time and frequency domain to simulate the fluid-structure aeroelastic interaction and CFD codes to study the aerodynamics. The student will have to design and perform appropriate wind tunnel tests to verify the numerical approach and to measure the coefficients that will be used in the numerical approach. Typical structures involved in the activity are slender structure like bridges, blades of wind turbines, cables, roofs and so on.</td>
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<th>Educational objectives</th>
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### Job opportunities

National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.

List of 5 Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

- University of Notre Dame
- TU Delft
- KTH
- ARUP
- RWDI

### Composition of the research group

- 10 Full Professors
- 7 Associated Professors
- 18 Assistant Professors
- 23 PhD Students

### Name of the research directors

Bocciolone, Brun, Cheli, Pennacchi, Resta, Zasso

### Contacts

Supervision of this research topic: Alberto Zasso, Federico Cheli, Marco Belloli, Daniele Rocchi
alberto.zasso@polimi.it
federico.cheli@polimi.it
marco.belloli@polimi.it
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Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: INFLUENCE OF SMART TIRES ON CONTROL STRATEGIES FOR IMPROVING VEHICLE HANDLING AND STABILITY

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Context of the research activity

Motivation and objectives of the research in this field

Advances in sensor technology lead to the development of new active control strategies as well as to Advanced Driver Assistance Systems (ADAS). Many key parameters relevant to the tire-road interface are still obtained though indirect estimation based on (mostly linear) state observers. The knowledge of slippages, slip angles, contact forces and, most of all, the tire-road friction coefficient, would provide essential information about the vehicle dynamics thus allowing to develop the next generation of control logics with significant enhancements in terms of vehicle performance and safety.

Methods and techniques that will be developed and used to carry out the research

Aim of the thesis is to investigate possible improvements of control logics present on ordinary vehicles (ESP, ABS, etc.) with the knowledge of some tire-road parameters provided by smart tires, i.e. tires with embedded sensors and digital computing capabilities.

Educational objectives

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### Job opportunities

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List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

- Berkeley University San Francisco USA
- Ferrari Auto S.p.A.
- Pirelli Tyre S.p.A.
- Volvo

### Composition of the research group

- 10 Full Professors
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Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: POWER TRAIN AND ENERGY MANAGEMENT STUDY FOR ELECTRIC AND HYBRID VEHICLES

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Context of the research activity

Motivation and objectives of the research in this field

The decreasing of the availability of fossil fuels and the environment issues, pushes the research towards the development of high efficiency power trains for vehicles that transport people, goods and mobile operating machines. In this general situation the road vehicle group research activity is also involved in the study of innovative high efficient power train system considering both the sizing of the components and the energy management strategies for fuel consumption minimization on hybrid vehicles.

Methods and techniques that will be developed and used to carry out the research

The PhD candidate activity will start with the definition of a full energetic model of the vehicle that will be considered for the study. The aim of this phase is the sizing of the power train and the definition of the general energetic management algorithm. Then the second phase consists of the experimental test of the power train in the labs using the established test benches available. At last the tests of the vehicle will be performed with particular attention paid to the validation of the numerical simulation model previously developed and to the fine tuning of the on board energy management.
**Educational objectives**

We provide doctoral candidates with high-level scientific training, fostering and refining research and problem solving abilities by focusing on both theoretical and experimental skills. A PhD in Mechanical Engineering will be able to layout, draft and carry on original research, by leading a research group or working in a team.

**Job opportunities**

National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.

List of 5 Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:

- Tsinghua University, Pechin, China
- Berkeley University San Francisco USA
- Ferrari Auto S.p.A.
- Pirelli Tyre S.p.A.
- CIFA S.p.A.

**Composition of the research group**

- 10 Full Professors
- 7 Associated Professors
- 18 Assistant Professors
- 23 PhD Students

**Name of the research directors**

Bocciolone, Brun, Cheli, Pennacchi, Resta, Zasso

**Contacts**

Supervision of this research topic: Federico Cheli, Davide Tarsitano, Ferdinando Mapelli
federico.cheli@polimi.it
davide.tarsitano@polimi.it
ferdinando.mapelli@polimi.it

For further information http://www.mecc.polimi.it/en/research/research-lines/dynamics-and-vibration/

For general information:
Additional support - Financial aid per PhD student per year (gross amount)

<table>
<thead>
<tr>
<th>Housing - Foreign Students</th>
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<tbody>
<tr>
<td>Housing - Out-of-town residents</td>
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<tr>
<td>(more than 80Km out of Milano)</td>
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</tbody>
</table>

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other informations

**Educational activities** (purchase of study books and material, funding for participation in courses, summer schools, workshops and conferences): financial aid per PhD student per year:
- 2nd year: 1.370 euro per student
- 3rd year: 1.370 euro per student

**Teaching assistantship:** availability of funding in recognition of supporting teaching activities by the PhD student

There are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

**Computer availability:**
- 1st year: individual use
- 2nd year: individual use
- 3rd year: individual use

**Desk availability:**
- 1st year: individual use
- 2nd year: individual use
- 3rd year: individual use
**PhD in MECHANICAL ENGINEERING - 30th cycle**

Research Area n. 1 - Dynamics and vibration of mechanical systems and vehicles

Research Field: RAILWAY NOISE AND VIBRATION

<table>
<thead>
<tr>
<th>Monthly net income of Ph.D. scholarship (max 36 months)</th>
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<tr>
<td>€ 1200.0</td>
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</table>

In case of a change of the welfare rates during the three-year period, the amount could be modified.

<table>
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<td><strong>Motivation and objectives of the research in this field</strong></td>
</tr>
<tr>
<td>Noise and vibration often give rise to concerns during the planning and the operation of railway lines. The complex problems to be faced require in deep knowledge of train-track dynamic interaction mechanisms and of the vibroacoustic phenomena which govern noise generation.</td>
</tr>
</tbody>
</table>

| **Methods and techniques that will be developed and used to carry out the research** |
| The PhD student working in this area will deal with real railway engineering problems, for either main lines, metros or urban tramways. The student will be asked to develop numerical models (in the frequency or in the time domain) to study and optimise potential noise/vibration control measures and will have the opportunity of participating in experimental activities. The research activity of the PhD student might be typically dealing with one of the following topics: train-track and train-turnout interaction, railway bridge runnability, ground-borne noise in metros, curve squeal noise in urban tramways. |

| **Educational objectives** |
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| Job opportunities                                                                 | National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.  
| List of Universities, Companies, Agencies and/or National or International Institutions that are cooperating in the research:  
Institute of Sound and Vibration Research (ISVR), University of Southampton, UK |
| Composition of the research group                                               | 10 Full Professors  
7 Associated Professors  
18 Assistant Professors  
23 PhD Students |
| Name of the research directors                                                | Bocciolone, Bruni, Cheli, Pennacchi, Resta, Zasso |

**Contacts**

Supervision of this research topic: Stefano Bruni, Andrea Collina, Roberto Corradi  
stefano.bruni@polimi.it  
andrea.collina@polimi.it  
roberto.corradi@polimi.it  

For further information http://www.mecc.polimi.it/en/research/research-lines/dynamics-and-vibration/

For general information:  
silvia.barattieri@polimi.it

**Additional support - Financial aid per PhD student per year (gross amount)**
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