

**Institute of Applied Mathematics and Mechanics  
St. Petersburg Polytechnic University**

**Institute for Problems in Mechanical Engineering  
Russian Academy of Sciences**

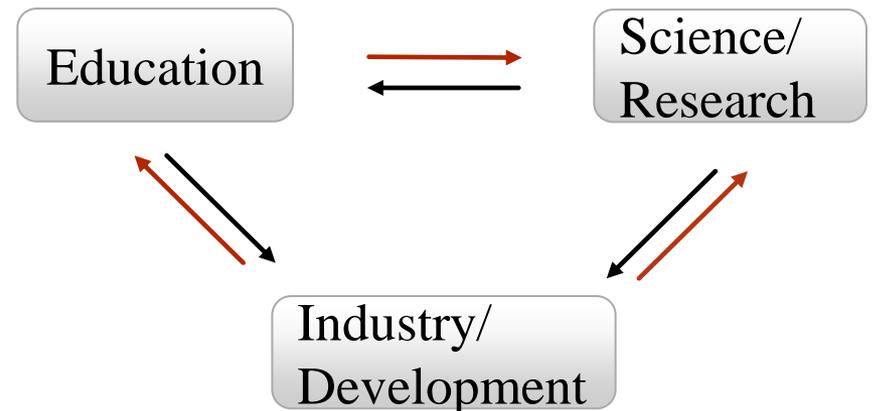
*International Master Degree Program*  
**Continuum Mechanics:  
Fundamentals and Applications**

# Objective of the program



Masters capable of *formulating and solving* a wide range of problems arising in various fields of continuum mechanics

- both mechanics of solids and fluids
- both fundamental research and engineering applications
- interdisciplinarity
- in the spirit of the **STEM** education concept aimed at obtaining 21st century skills in science, technology, engineering, and mathematics.



# Key facts

- Being enrolled in MSc Program “Continuum mechanics: fundamentals and applications” means practically oriented learning, mentoring and scientific guidance from prominent professors of the **Institute of Applied Mathematics and Mechanics of St. Petersburg Polytechnic University** (Departments of Mechanics and Processes Control, Hydroaerodynamics, Applied Mathematics, Continuum Mechanics), recognized scientists from the **Institute for Problems in Mechanical Engineering of Russian Academy of Science** that is one of the leading research institutions in the field of mechanics of materials, and **invited professors from top world universities: TU Berlin, TU Delft, École Polytechnique, University of Illinois at Chicago.**
- The focus is placed, on the one hand, on **interdisciplinarity**, which is a current trend in mechanics, and the program topics include phase transformations, mechanochemistry, biological systems etc., and on the other hand, on deep learning of basic subjects of continuum mechanics and applied mathematics. As a result, the graduates will acquire competencies which are necessary to **both fundamental and applied research** in theoretical and computational mechanics of solids, gas and fluids as a unit, and, thus, being prepared for prospective international careers.
- We possess not only the extensive experience in research and teaching, but also broad **international contacts**, which we are eager to share with our students for their future career. This provides **academic mobility and internships** at the universities all around the world. We also expect the MSc Program to be approved by **ECMI** (European Consortium for Mathematics in Industry) that in turn will give additional opportunities for academic mobility.

# Training courses

2 years, full-time, regular and modular courses, 120 ECTS

(30 ECTS for the Master's Thesis)

- **Fundamentals:** Mechanics and Thermodynamics of Continua; Elasticity; Plasticity; Fracture Mechanic; Micromechanics, Rods and Shells, Waves in Continua, Fluid Mechanics, Multiphase Flows, Turbulence Modeling, Research and Developments of Mechatronic Systems (42 ECTS)
- **Computational Solid and Fluid Mechanics** (8 ECTS)
- **Mechanics and Applied Mathematics in Natural Sciences and Technologies:** blocks of lectures given by leading scientists from European and USA universities on various topics in mechanics and applied mathematics (8 ECTS).
- **Mathematical foundations:** Tensor Calculus; Functional Analysis; Numerical methods for PDE's; Reliable Modeling and Error Control (A Posteriori Error Analysis); Advanced Topics in Probability, Stochastic Processes and Statistics (16 ECTS)
- **Research and Modeling Seminar:** all students are given a problem-project to solve either individually or in minigroups, and the results are then discussed altogether (16 ECTS)

# Continuum mechanics: fundamentals and applications

## Curriculum

### 1<sup>st</sup> semester (30 ECTS) Focus on basic competencies

- Mechanics and Thermodynamics of Continua (5 ECTS)
- Mechanics of Solids (6 ECTS): Elasticity, Plasticity
- Fluid Mechanics (5 ECTS)
- Computational Solid and Fluid Mechanics (4 ECTS)
- Advanced Math (6 ECTS) : Functional Analysis I; Numerical methods for PDE's I; Tensor Calculus.
- Research and Modeling Seminar (4 ECTS)

### 2<sup>nd</sup> semester (30 ECTS) Focus on core professional competencies

- Fracture Mechanics (3 ECTS)
- Micromechanics in Strength and Plasticity (3 ECTS)
- Waves in Continua (3 ECTS)
- Multiphase Flows (3 ECTS)
- Computational Solid and Fluid Mechanics (4 ECTS)
- Mechanics and Applied Mathematics in Natural Sciences and Technology (4 ECTS)
- Advanced Math (5ECTS): Functional Analysis II; Numerical methods for PDE's II.
- Research and Modeling Seminar (5 ECTS)

### 3<sup>rd</sup> semester (30 ECTS) Focus on advanced knowledge

- Fracture Mechanics and Micromechanics of Heterogeneous Media (5 ECTS)
- Mechanics of Rods and Shells (3 ECTS)
- Research and Developments of Mechatronic Systems (3 ECTS)
- Turbulence Modeling (3 ECTS)
- Mechanics and Applied Mathematics in Natural Sciences and Technology (4 ECTS)
- Advanced Math (5 ECTS): Reliable Modeling and Error Control; Parallel Algorithms for Scientific Applications; Advanced Topics in Probability, Stochastic Processes and Statistics.
- Research and Modeling Seminar (7 ECTS)

**4<sup>th</sup> semester (30 credits): MSc Thesis**

# Modular courses

**Regular courses, strengthened by learning-by-doing and modular training.**

“**Mechanics and Applied Mathematics in Natural Sciences and Technology**” is a modular course during which **leading scientists from top world universities** offer students challenging courses and highlight cutting-edge issues. After the end of each module the communication and possible collaboration with the invited lecturer may be continued on-line to provide support with research projects as well as theses.

## Modules:



**Rational Electrodynamics of Materials** (Prof. W. H. Müller)

**Nonlinear deformation of solids in particular rubber** (Prof. W. H. Müller)



**Perturbation Methods for Nonlinear Continuous Dynamical Systems**  
(Prof. W. T. van Horssen)



**Fatigue and shakedown** (Prof. Eric Charkaluk)



**Experimental and Theoretical Fracture Mechanics**  
(Prof. Alexander Chudnovsky)



# National Research University “Saint Petersburg Polytechnic University”



Since its foundation in 1899, SPbPU is one of the leading technical universities in Russia and famous for many talented scientists and researchers including 3 Nobel Prize winners. Today SPbPU is the Russian top-rated technical university noted for the quality of education and scientific research. It comprises 11 Institutes in Engineering, Computer Science, Technical Physics, Power Engineering, Economics and Humanities with more than 30000 students enrolled.

In 2010 SPbPU received the prestigious status of “National Research University”. Modernization of the educational system and integration of SPbPU within the European higher educational system are the strategic priorities of the university’s development policy. Providing answers to global challenges, SPbPU invites you to join its international educational programs.

[www.eng.spbstu.ru](http://www.eng.spbstu.ru)



# National Research University “Saint Petersburg Polytechnic University”

- Campus area – 102 ha
- Buildings – 112
- Institutes – 12
- Total number of students – 26500
- Foreign students – 1900
- Undergraduate and graduate programs – 92
- Postgraduate programs – 92
- Teachers – 2730
- University staff – 6000



# Institute of Applied Mathematics and Mechanics

Highest level of theory combined with emphasis on applications

Institute of Applied Mathematics and Mechanics of SPbSPU was created on the basis of the Department of Physics and Mechanics. The combination of academic learning and scientific research is a principle stated by A.I. Ioffe, the founder of the department. Nowadays this principle is fundamental in the Institute's educational process. The Institute's academic staff consists of highly qualified professors, associate professors, and scientists.

## Teaching staff:

63 Full Professors  
133 Associate Professors  
88 Assistant Professors

## Research staff:

61 persons  
**Technical staff:**  
108 persons

## Students:

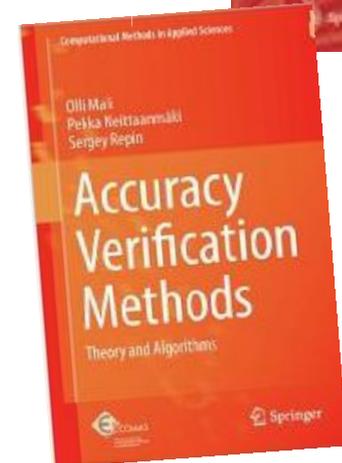
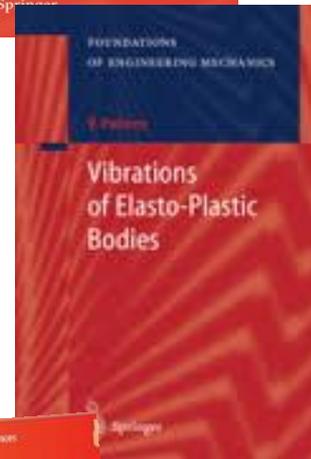
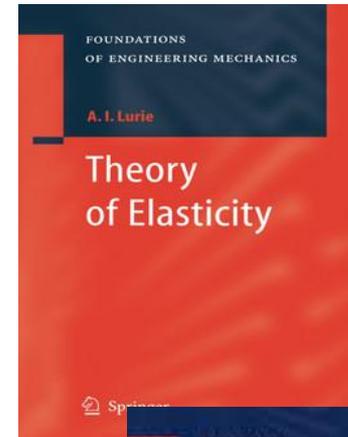
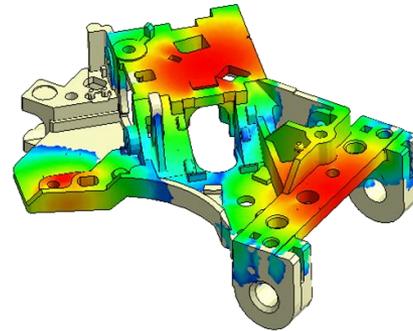
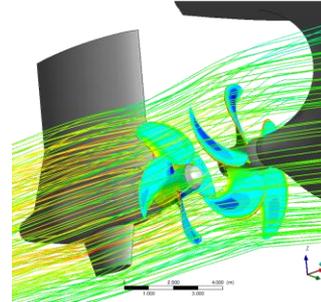
518 BSc students  
193 MSc students  
42 PhD students



First curriculum for  
Mechanics was  
developed by Professor  
Stepan Timoshenko

# Research in IAMM

- Mechanics of Solids
- Fluid Mechanics
- Computational Mechanics and Mathematics. Computer Aided Engineering based on Finite Element Mechanics:
- Micro- and Nanomechanics
- Mechanics of Discrete Systems
- Dynamics and Strength of Machines
- Mechatronics
- Biomechanics
- Applied Mathematics and Statistics
- Computer Science



# Institute for Problems in Mechanical Engineering of Russian Academy of Sciences



IPME RAS was established in 1987. Now this is one of the recognized scientific centers in the field of applied mechanics with focus on **both fundamental and engineering** problems.

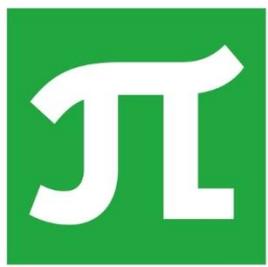
Main research fields:

- mechanics of materials from nano- to macro
- phase transitions, including stress-induced transformations
- mechanochemistry
- defects and damage mechanics
- reliability of machines and constructions
- vibratory, wave and vibroimpact processes
- modelling control processes in complex physical and technical systems



The Institute has close contacts with leading St. Petersburg Universities. The **Department of Mechanics and Processes Control** shares the responsibility for the Educational Program with **Department of Continuum Mechanics** affiliated by IPME RAS to the University

[www.ipme.ru](http://www.ipme.ru)



# Prospective Program Partners

IPME



JOHANNES KEPLER  
UNIVERSITÄT LINZ | JKU



University  
of Glasgow



## How to get enrolled

<b>Admission requirements</b>	Candidates are required to hold a Bachelor, Specialist or Master degree in a related subject area. English language proficiency at B2 level is required for all applicants .
<b>Admission tests</b>	Examination in the field of mechanics and applied mathematics and an interview with the program coordinator (optionally – via Skype).
<b>Admission procedure</b>	Written on-line application. Application deadline – June, 30. International applicants may find additional information concerning admission at the official website of SPbPU: <a href="http://imop-spbpu.ru/en/add_ed/docs_and_tests_int_students">http://imop-spbpu.ru/en/add_ed/docs_and_tests_int_students</a> Manager of Admission office for international students: <a href="mailto:interadmisson@imop.spbstu.ru">interadmisson@imop.spbstu.ru</a>
<b>Semester start</b>	Winter semester – September, 1.
<b>Length of program</b>	Full program: 2 years, 120 ECTS Semesters: details are available upon request <a href="mailto:interadmisson@imop.spbstu.ru">interadmisson@imop.spbstu.ru</a> , <a href="mailto:mobility@spbstu.ru">mobility@spbstu.ru</a>
<b>Degree awarded</b>	Master of science (MSc)

# Program scientific supervisor



**Alexander B. Freidin**, Dr. Sci., Professor

- Professor of the Department of Mechanics and Processes Control, Chair of the Department of Continuum Mechanics, Institute of Applied Mathematics and Mechanics of St. Petersburg Polytechnic University
- Head of the Department of Mathematical Methods in Mechanics of Materials and Structures, Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences

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**E-mail: [alexander.freidin@gmail.com](mailto:alexander.freidin@gmail.com)**

## Program coordinator



**Roman Filippov**, PhD., Associate Professor

- Department of Mechanics and Processes Control, Institute of Applied Mathematics and Mechanics of St. Petersburg Polytechnic University
- Senior researcher of the Department of Mathematical Methods in Mechanics of Materials and Structures, Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences

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