

High Level Education in High Performance Computing: MHPC. Application Call 2024 - 2025

SISSA and ICTP promote a 12 months education program in High Performance computing.

The program spans the academic year 2024-2025, starting from **September 9, 2024**.

Short description

The specialization course (Corso di Perfezionamento) Master in High Performance Computing (MHPC) hosted and organized by SISSA (International School for Advanced Studies) and ICTP (Abdus Salam International center for theoretical physics), is an innovative degree program devoted to training students in the booming field of HPC. SISSA and ICTP are well-known first rank institutions in applied and theoretical mathematics and physics.

MHPC is an innovative educational program, that trains scientists and professionals in modern computational technologies. MHPC trains students in taking the right decision with the right tools for each computational problem. Students that complete the Master have a solid background in scientific computing approaches, algorithms, and modeling.

The program combines lectures with hands-on tutorials. Tutorial sessions are strongly application-oriented, and a final thesis defense completes the program.

Courses

Courses are organized in full-day programs which include active lectures during the morning and practice hands-on tutorials during the afternoon. They are held by internationally renowned scientists. Tutorial sessions are strongly application-oriented and will be used to assess the learning process.

As the field of high performance computing belongs to the cutting edge of the quickly changing advanced technology world, the exact courses are subject to variations from one edition to another. Here we report an example program for one of the previous editions.

PART I, HPC Concepts and Programming: ~4 months

The first part focuses on the general skills needed by every high performance computing specialist and is intended to build the foundations for acquiring more advanced skills during the second part. All courses of the first part are mandatory.

- **1.1 Scientific programming environment** **6 CFU**
- **1.2 Advanced Programming** **6 CFU**
- **1.3 Introduction to Computer Architectures for HPC** **3 CFU**
- **1.4 Introduction to Parallel Programming** **6 CFU**
- **1.5 Advanced Parallel Programming** **6 CFU**
- **1.6 Data Structures & Sorting and Searching** **3 CFU**
- **1.7 Best Practices in Scientific Computing I** **3 CFU**
- **1.8 Modern Python for Scientific Computing** **3 CFU**
- **1.9 Introduction to Numerical Analysis** **3 CFU**
- **1.10 Advanced Linear Algebra Libraries and Accelerators** **3 CFU**

- **1.11 Supervised Machine Learning** **3 CFU**
- **1.12 Unsupervised Machine Learning** **3 CFU**

PART II, HPC Algorithms for Science and Technology: ~5 months

The second part of the master is devoted to implementing HPC strategies in non standard scientific and industrial applications. This part is composed of both mandatory and optional courses (based on the students' interests and on their project needs). The exact number of required CFUs for each student is discussed with the program coordinator and with the student's advisor and may vary on a case-by-case basis. Optional courses will be activated only if a sufficient number of students will be attending. The second part is spread from February to May included.

- **2.1 KS solvers (mandatory)** **3 CFU**
- **2.2 Introduction to *PETSc* (mandatory)** **3 CFU**
- **2.3 Introduction to Deep Learning (mandatory)** **3 CFU**
- **2.4 Parallel Fast Fourier Transforms Multiple Dimensions (optional)** **2 CFU**
- **2.5 Finite Element Methods with Dealii (mandatory)** **3 CFU**
- **2.6 Deep Learning (optional)** **6 CFU**
- **2.7 Reduced Basis Methods (optional)** **3 CFU**
- **2.8 Approximation and interpolation of complex functions (optional)** **2 CFU**
- **2.9 Reinforced Learning (optional)** **3 CFU**
- **2.10 Introduction to Quantum Computing (mandatory)** **3 CFU**
- **2.11 Hardware Architectures (mandatory)** **2 CFU**
- **2.12 Molecular Dynamics (optional)** **3 CFU**
- **2.13 High Performance Computing Technology (mandatory)** **6 CFU**
- **2.14 Advanced Computer Architectures & Optimizations (mandatory)** **3 CFU**
- **2.15 N-Body Systems on GPUs (mandatory)** **3 CFU**

PART III, HPC Thesis development: 4 – 9 months

During the last period of the master, students will develop a technically and scientifically challenging project in collaboration with an ongoing research team and/or an industrial partner. In their projects, students apply the skills developed in the previous sections of the program. Project proposals must be submitted to and accepted by a MHPC thesis committee and must be overseen by a qualified adviser. The project should not last more than nine months (unless it is already part of a larger PhD project) and should then be reported in a written thesis. The thesis development may overlap with the second part of the courses. During the thesis project, students may be supported by fellowships from sponsoring institutions or industrial partners. A thesis defense completes the program.

Fees

The MHPC fee is € 7.000,00.-. Non-EU applicants who require a VISA may need to provide proof of financial coverage for the master fee and for the living expenses

during the entire duration of the master course. **MHPC does not provide any financial coverage.** Any agreement with external financial institutions or contributed company must be undertaken by the candidates themselves before the deadline of the MHPC applications (see www.mhpc.it for available scholarships or contributions).

External support for students from developing countries

ICTP offers every year a variable number of scholarships for applicants from developing countries, covering the MHPC fees as well as the cost of living expenses. The deadline for the applications for these scholarships is typically at the end of March (much earlier than the deadline for the application to MHPC itself), due to time restrictions in the VISA request procedures. Please consult the website www.mhpc.it for the exact deadlines for these scholarships. The scholarships are provided by ICTP (not by MHPC), and *winners are automatically admitted to MHPC.*

Support for SISSA PhD students and former SISSA PhD students

SISSA waves the fee of MHPC to its PhD students who are enrolled on one of its PhD courses on the date of the official start of MHPC classes, and to former students who have obtained their doctorate no more than 12 months before the start date of the lessons and that are currently unemployed, for a maximum of *six exemptions*. The exemption is granted to the first three PhD students and to the first three former PhD students that are admitted to the Master, according to the ranking of the admission.

Should the number of admitted students or former students be less than three, the exemptions not enjoyed by one of the two categories will be transferred to the other. Beneficiaries of the exemption are required to complete the training course, under penalty of paying € 1.000,00.- to SISSA, as a contribution to the training costs.

If the beneficiary of an exemption is awarded a scholarship that also includes a contribution for the fees (see next section), the benefit of the exemption is withdrawn and the student is required to pay the balance of the entire fee for participation in MHPC.

SISSA PhD students are encouraged to enroll in MHPC from their second year to the end of the PhD. If they result among the admitted MHPC students, they must obtain a *nulla osta* from their advisors and from the “collegio dei docenti” of their PhD. SISSA PhD scholarships are *not* compatible with other research scholarship and cannot be cumulated.

PhD students of external institutions

Other universities are invited to send their PhD students to attend MHPC program from September to May. In that case, they are responsible for covering the MHPC fee of € 7.000,00.-. The application process is ongoing from February until the available places are filled with suitable candidates.

External scholarships

Other research institutes as well as private companies and industries may offer scholarships to cover the fee of the master and/or partial/full living expenses. All of

these scholarships will be advertised on the website www.mhpc.it, and will have their own deadlines and conditions. These are independent with respect to the MHPC application and deadline, and application/admission to these scholarships **will not** imply application/admission to MHPC, which must be actuated separately. The only exception to this rule is given by winners of ICTP scholarships for developing countries, who are granted admission to MHPC.

Prerequisites

MHPC is accessible by Italian students graduated with “laurea magistrale (D.M. 270/2004)” and “laurea Vecchio Ordinamento (L. 341/1990)”. International applicants with a Bachelor, Master, or Doctoral degree are welcome to apply.

Application Procedure

The application procedure is available online at www.mhpc.it. The deadline for the applications is set to **May 15, 2024 at 11:59 am**.

Evaluation Procedure

Online applications will be evaluated mostly on the applicant curriculum. A short phone or online interview may be required. Admitted applicants from non-EU countries must be able to complete any required VISA procedures before the start of the courses (**September 9, 2024**).

MASTER IN HIGH PERFORMANCE COMPUTING

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