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Manifesto of the International Master Program in Data Science and Scientific Computing

Degree Class: Mathematical-Physical Modelling in Engineering, LM-44 - cod. SM35
Cohort for the academic year 2017/2018

For more information visit the website of the course:

http://dssc.units.it

Objectives

The MSc in Data Science and Scientific Computing wants to prepare professionals who are ready to face the challenges of the modern digital society: experts in data analysis and data management, in particular of big datasets, and in computational modeling with applications in science and engineering .

The training objectives of the MSc in DSSC are:

- Handling complex problems in a multidisciplinary field by building mathematical and / or statistical models and analyzing them with appropriate computational techniques;
- Knowing which computational techniques and technology tools are needed to solve these problems as efficiently as possible;
- Communicating and interact with experts in other disciplines, with the appropriateness of language and understanding of the main problems in these areas;

By the end of the MSc, students will not only acquire theoretical skills, but will also learn how to apply theory to solve practical problems, through individual exercises, group work, seminars, and internship.

Students will also develop good communication skills to interact with other professionals and to communicate results, and they will learn how to refresh their professional skills and suggest innovative solutions.

Scholarships

For information on any scholarships to support the participation in the master's degree, please refer to the dedicated page of the course website: https://dssc.units.it/scholarships.

Calendar of lessons and exam sessions

The academic year 2017/2018 is organized in two teaching periods and three periods for exam sessions.

Teaching Period	*Start of Lessons*	*End of Lessons*
I period	October 02, 2017	January 19, 2018
II period	March 05, 2018	June 15, 2018

For more details see http://dssc.units.it

Admission to the Master Degree Course

The Master's Degree in Data Science and Scientific Computing will accept for the academic year 2017/2018 up to 30 students.

The selection of candidates will be made by an admission committee, according to the terms of the call for application, which will be available at the university website. See also the "How to Apply" page of course website

The selection procedure takes place in two phases. The first phase involves checking the curricular requirements for the access, as provided for in the Regolamento Didattico (teaching regulations) and later detailed. Candidates admitted to the second phase will be interviewed. At the end of the interviews, a ranking of candidates will be released.

Admission to the selection process for the Master of Science degree in Data Science and Scientific Computing is for candidates satisfying all the following requirements:

A. Holding a Bachelor's Degree (or equivalent) or a three-year University Diploma, or any other equivalent degree obtained abroad.
B. Having a degree mark of at least 95/110 (for italian degrees). Equivalence for non-italian degree holders will be discussed on a case by case basis.
C. Having acquired at least 60 European University Credits (ECTS) in one or more of the following disciplines (in parenthesis, the italian classification of scientific disciplines): Mathematics (MAT/*), Computer Science (INF/01), Information Engineering (ING-INF/*), Industrial Engineering (ING-IND/*) Civil Engineering (ICAR/01-09), Physics (FIS/*), Statistics and Mathematical Methods for Economics and Finance (SECS-S/*), Chemistry (CHIM/*), Geophysics and Earth Physics (GEO/10, GEO/12), of which at least 12 ECTS of Mathematics (MAT/*, SECS-S/06) and 6 ECTS of Informatics (INF/01, ING-INF/05).
D. Having an adequate knowledge of English, certified by internationally recognized certification (level B2 or equivalent, see Annex D).

The selection procedure consists of an evaluation of the curriculum and an interview for the candidates, either in person or telematically, when requested. The interview aims to verify in detail the actual competence, preparation and motivation of the candidate, and is generally held in English. During the interview, the actual knowledge of the English language will in any case be tested. If the student is not in possession of an international certification, passing this test is a necessary condition for admission. In any case, in order to finalize the enrollment, the student will have to submit the language certification within the time limits set by the call for admission. Where deemed necessary, the commission may require one or more written and / or practical tests to be carried out.

Please refer to the Call for Enrollment for more information on selection criteria, timing, and evaluation methods.

Training Activities

The Master's Degree lasts two years and includes training activities of five different types:

- Courses in one or more characterizing areas (type B).
- Courses in one or more disciplinary area that are similar or complementary to the basic and characterizing ones, including interdisciplinary training (type C);
- Courses independently chosen by the student as long as they are consistent with the training project (type D);

- Training activities related to the preparation of the final test for the achievement of the Title of study (type E);
- Training activities not included for in the previous points, aimed at acquiring further language skills, as well as computer and telematic skills, relational, or otherwise useful for job placement, as well as training activities aimed at facilitating professional choices through direct knowledge of the job sector to which the degree may give access, including, in particular, the training and orientation placements referred to in decree no. 142, of the Ministry of Labor (type F).

The following table lists the courses of the Master's Degree Course in Data Science and Scientific Computing active in aa. 2017/18 (first year courses only) and aimed at the acquisition of CFUs in their respective course year. See also Annex C for the training objectives of the courses listed in the table.

Course	***SSD***	***TAF***	***ECTS***	***YEAR***	***SEM***
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I	I
Numerical Analysis	MAT/08	B	6	I	I
Data Management for Big Data	INF/01	B	9	I	II
Statistical Methods for Data Science	SECS-S/01	C	6	I	II
Statistical Machine Learning	INF/01	B	6	I	II
Stochastic Modelling and Simulation	INF/01	B	6	I	II
Advanced Numerical Analysis	MAT/08	B	6	I	II
Optimisation Models	MAT/09	B	9	I	II

Study plan

The Master Degree course in DSSC is organized into two curricula: the curriculum in Data Science and the curriculum in Computational Science and Engineering.

The Data Science curriculum forms qualified graduates in data management and analysis, with particular attention to Big Data. Students will acquire skills in statistics, modeling, data analytics, high performance computing, and database management for big data.

The Computational Science and Engineering curriculum forms qualified graduates in Computational Science and Engineering. Students will acquire skills in mathematical modeling, knowledge of numerical simulation methods, data analytics, high performance computing, and scientific programming.

A description of the structure of the curricula, with tables describing how many credits for each type of training activity are required is available in Annex A.

Both curricula have specializations, each associated with a study plan, designed to guide the student in choosing the second year courses. Each of these study plans has a focus on a specific topic or methodology. The list and the details of these study plans are available in Annex B. The student intending to follow a study plan outside the proposed ones must still comply with the constraints of Annex A.

Final Examination and Graduation

The final exam to graduate successfully in the MSc in Data Science and Scientific Computing corresponds to 24 ECTS of work, and consists in the preparation of a dissertation, proposing an original solution to a scientific or business problem. The dissertation must describe clearly the problem addressed within the specific field and be accompanied by an adequate bibliography.

To be admitted to the final exam, the student must have completed all the exams and earned all the credits expected, with the exception of those for the final exam, by the fifteenth day before the graduation date. The dissertation must also have been uploaded in the university database within the eighth day before graduation.

The dissertation will be carried out under the guidance of a supervisor, usually a professor of the MSc faculty, whose name must be communicated promptly to the coordinator of the program. The supervisor may be a professor of the university of Trieste or Udine not belonging to the MSc faculty, subject to approval. There may be one or more co-supervisors, not necessarily part of the faculty. The dissertation can be carried out in a research laboratory or in a company, subject to the authorization of the MSc council.

The thesis will be written and discussed in English. Appropriately justified exceptions must be authorized by MSc council.

The student will have two give two seminars before the final submission of the dissertation work: a progress report in itinere, and a technical presentation seminar before the final exam (prelaurea). For each of these seminars, the Coordinator of the MSc will appoint a committee of three lecturers, including the supervisor. The committee will give feedback to the student after the progress report. The prelaurea committee, on the other hand, will give a judgment on the student's work, proposing an increment in the final score according to the way the final vote is awarded.

The final exam consists of a brief discussion of the dissertation. The discussion must be understandable to an educated audience but non-specialist in the topics of the dissertation.

The final grade is based on the evaluation of the curriculum of studies, on the content of the dissertation and its presentation, and on further training activities carried out by the student. The overall grade is obtained from the weighted average (by the relative ECTS) of the examination marks converted in a scale from 0 to 110. To this figure, the graduation committee will add a maximum of 10 points, reflecting the quality of the dissertation and of its presentation. The ‘cum laude’ can be awarded if the candidate has reached the maximum grade of 110, and it requires the unanimity of the graduation committee.

The calendar of graduation sessions is published online on http://dssc.units.it

ANNEX A: STUDY PLAN

The MSc in Data Science and Scientific Computing has 2 curricula:

- Curriculum "Data Science"
- Curriculum "Computational Science and Engineering"

Curriculum "Data Science"

The curriculum in Data Science trains experts in data management and analysis, with a special focus on Big Data. Students will acquire skills on statistics, modelling, data analytic, high performance computing and management of databases for big data.

Curriculum "Data Science"			
I year (60 ECTS)			
Course	*SSD*	*TAF*	*ECTS*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Foundations of High Performance Computing	ING-INF/05	B	9
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6
Numerical Analysis	MAT/08	B	6
Data Management for Big Data	INF/01	B	9
Statistical Methods for Data Science	SECS-S/01	C	6
Statistical Machine Learning	INF/01	B	6
II Year (60 ECTS)			
Course	*SSD*	*TAF*	*ECTS*
Optional courses		C	12
Free choice courses		D	12
Internship and seminar courses		F	12
Thesis		E	24

In the study plan you can enter some optional courses (TAF C) to be chosen between:

Optional Courses			
Course	*SSD*	*TAF*	*CFU*
Stochastic Modelling and Simulation	INF/01	C	6
Optimisation Models	MAT/09	C	9
Network Science	INF/01	C	6
Information Retrieval	ING-INF/05	C	6
Social Network Analysis	SECS-S/05	C	6
Big Data Bioinformatics	INF/01	C	6
Genomic Data Analytics	MED/03	C	6
Cyber-Physical Systems	INF/01	C	6
Health Data Analytics	MED/01	C	6
Software Development Methods	ING-INF/05	C	6
Optimisation and Design	ING-IND/08	C	9

In the study plan you can enter some free choice courses (TAF D) that can be selected from those listed below, or from any course available in the university of Trieste, provided its compatibility with the training program. Please check the actual activation of the following courses in the year of interest.

Free Choice Courses			
Course	*SSD*	*TAF*	*CFU*
All courses of previous tables		D	
Open Data Management and the Cloud	ING-INF/05	D	6
Computer Vision and Pattern Recognition	ING-INF/05	D	6
Bayesian Statistics	SECS-S/01	D	6
Algorithms for Massive Data	INF/01	D	6
Management of Health Data	ING-INF/06	D	6
Biomedical Signals and Bioimage Analysis	ING-INF/06	D	6
Applied Genomics	BIO/18	D	6
Advanced Mathematical Methods	MAT/05	D	6

Advanced Numerical Analysis	MAT/08	D	6
Systems and Control Theory	ING-INF/04	D	9
Optimal and Robust Control	ING-INF/04	D	9
Molecular Simulation	ING-IND/24	D	9
Other courses (****) (****) They can belong to any SSD		D	

Curriculum "Computational Science and Engineering"

The curriculum in Computational Science and Engineering forms qualified graduates in Computational Science and Engineering. The student will acquire mathematical modeling skills, knowledge of numerical simulation methods, data analytics, computational intensive computing and scientific programming.

Curriculum "Computational Science and Engineering"			
I anYearno (60 ECTS)			
Course	*SSD*	*TAF*	*CFU*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Foundations of High Performance Computing	ING-INF/05	B	9
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6
Numerical Analysis	MAT/08	B	6
Stochastic Modelling and Simulation	INF/01	B	6
Advanced Numerical Analysis	MAT/08	B	6
Optimisation Models	MAT/09	B	9
II Year (60 ECTS)			
Course	*SSD*	*TAF*	*ECTS*
Optional courses		C	12
Free choice courses		D	12
Internship and seminar courses		F	12
Thesis		E	24

In the study plan you can enter some optional courses (TAF C) to be chosen between:

Optional Courses			
Course	*SSD*	*TAF*	*CFU*
Optimisation and Design	ING-IND/08	C	9
Systems and Control Theory	ING-INF/04	C	9
Optimal and Robust Control	ING-INF/04	C	9
Fluid Dynamics	ICAR/01	C	6
Computational Methods for Turbulent Fluids	ICAR/01	C	6
Advanced Mathematical Methods	MAT/05	C	6
Computational Physics Laboratory	FIS/01	C	6
Computational Quantum Chemistry	CHIM/02	C	6
Molecular Simulation	ING-IND/24	C	9
Astrophysics	FIS/05	C	6
Formation of Cosmological Large-Scale Structures	FIS/05	C	9
Statistical Machine Learning	INF/01	C	6
Cyber-Physical Systems	INF/01	C	6
Software Development Methods	ING-INF/05	C	6

In the study plan you can enter some free choice courses (TAF D) that can be selected from those listed below, or from any course available in the university of Trieste, provided its compatibility with the training program. Please check the actual activation of the following courses in the year of interest.

Free Choice Courses			
Course	*SSD*	*TAF*	*CFU*
All courses of previous tables		D	
Data Management for Big Data	INF/01	D	9
Network Science	INF/01	D	6
Statistical Methods for Data Science	SECS-S/01	D	6
Big Data Bioinformatics	INF/01	D	6
Open data management and the cloud	ING-INF/05	D	6

Information Retrieval	ING-INF/05	D	6
Bayesian Statistics	SECS-S/01	D	6
Social Network Analysis	SECS-S/05	D	6
Algorithms for Massive Data	INF/01	D	6
Computer Vision and Pattern Recognition	ING-INF/05	D	6
Computational Fluid Mechanics	ING-IND/10	D	6
Biofluidodynamics	ING-IND/34	D	9
Environmental Hydraulics	ICAR/01	D	6
Statistical Mechanics	CHIM/02	D	6
Physics of Atmosphere	FIS/06	D	6
Oceanography	GEO/12	D	6
Theoretical Astrophysics	FIS/05	D	6
Numerical Methods in Quantum Mechanics	FIS/03	D	6
Simulation of Multibody Systems	FIS/03	D	6
Genomic Data Analytics	MED/03	D	6
Health Data Analytics	MED/01	D	6
Biomedical Signals and Bioimage analysis	ING-INF/06	D	6
Other courses (****) (****) They can belong to any SSD		D	

Remark: SSD is an italian categorization of scientific disciplines, which is alternative to ERC one, and is mainly used in academic staff recruitment. Check this web page for a translation of SSDs in English: goo.gl/nKX15c.
Here you can find an explanation of the italian grading system in the university: goo.gl/PYVFTC

ANNEX B: SPECIALIZATIONS AND PROPOSED STUDY PLANS

Curriculum: Data Science

Specialization in Data Science for Healthcare

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Data Management for Big Data	INF/01	B	9	II
Statistical Methods for Data Science	SECS-S/01	C	6	II
Statistical Machine Learning	INF/01	B	6	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Health Data Analytics	MED/01	C	6	II
Software Development Methods	ING-INF/05	C	6	I
Management of Health Data	ING-INF/06	D	6	I
At least 6 CFU between				
Biomedical Signals and Bioimage Analysis	ING-INF/06	D	6	I
Information Retrieval	ING-INF/05	C	6	II
Computer Vision and Pattern Recognition	ING-INF/05	D	6	I
Optimization Models	MAT/09	C	9	II
Open Data Management and the Cloud	ING-INF/05	D	6	I

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Data Science

Specialization in Data Science for Life Sciences

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Data Management for Big Data	INF/01	B	9	II
Statistical Methods for Data Science	SECS-S/01	C	6	II
Statistical Machine Learning	INF/01	B	6	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Genomic Data Analytics	MED/03	C	6	II
Big Data Bioinformatics	INF/01	C	6	I
Applied Genomics	BIO/18	D	6	I
At least 6 CFU between				
Algorithms for Massive Data	INF/01	D	6	II
Stochastic Modelling and Simulation	INF/01	C	6	II
Molecular Simulation	ING-IND/24	C	9	I

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Data Science

Specialization in Data Science for Social Sciences

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Data Management for Big Data	INF/01	B	9	II
Statistical Methods for Data Science	SECS-S/01	C	6	II
Statistical Machine Learning	INF/01	B	6	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Network Science	INF/01	C	6	I
Social Network Analysis	SECS-S/05	C	6	II
Information Retrieval	ING-INF/05	C	6	II
At least 6 CFU (12 TAF D) between				
Bayesian Statistics	SECS-S/01	D	6	II
Stochastic Modelling and Simulation	INF/01	C	6	II
Optimisation Models	MAT/09	C	9	II

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Data Science

Specialization in Foundations of Data Science

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Data Management for Big Data	INF/01	B	9	II
Statistical Methods for Data Science	SECS-S/01	C	6	II
Statistical Machine Learning	INF/01	B	6	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Software Development Methods	ING-INF/05	C	6	I
At least 6 CFU between				
Information Retrieval	ING-INF/05	C	6	II
Network Science	INF/01	C	6	I
At least 12 CFU (different course than those already selected) between				
Information Retrieval	ING-INF/05	C	6	II
Network Science	INF/01	C	6	I
Computer Vision and Pattern Recognition	ING-INF/05	D	6	I
Bayesian Statistics	SECS-S/01	C	6	II
Open Data Management and the Cloud	ING-INF/05	D	6	I
Algorithms for Massive Data	INF/01	D	6	II
Optimisation Models	MAT/09	C	9	II
Stochastic Modelling and Simulation	INF/01	C	6	II
Cyber-Physical Systems	INF/01	C	6	II

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Data Science

Specialization in Data Engineering

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Data Management for Big Data	INF/01	B	9	II
Statistical Methods for Data Science	SECS-S/01	C	6	II
Statistical Machine Learning	INF/01	B	6	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Software Development Methods	ING-INF/05	C	6	I
Network Science	INF/01	C	6	I
Open Data Management and the Cloud	ING-INF/05	D	6	I
At least 6 CFU between				
Information Retrieval	ING-INF/05	C	6	II
Computer Vision and Pattern Recognition	ING-INF/05	D	6	I
Bayesian Statistics	SECS-S/01	C	6	II

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Computational Science and Engineering

Specialization in Computational Fluid Dynamics

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Stochastic Modelling and Simulation	INF/01	B	6	II
Advanced Numerical Analysis	MAT/08	B	6	II
Optimisation Models	MAT/09	B	9	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Fluid Dynamics	ICAR/01	C	6	I
Computational Methods for Turbulent Fluids	ICAR/01	C	6	II
Advanced Mathematical Methods	MAT/05	C	6	I
At least 6 CFU between				
Software Development Methods	ING-INF/05	C	6	I
Biofluidodynamics	ING-IND/34	D	9	I
Environmental Hydraulics	ICAR/01	D	6	I
Physics of Atmosphere	FIS/06	D	6	II
Oceanography	GEO/12	D	6	II
Computational Fluid Mechanics	ING-IND/10	D	6	II

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Computational Science and Engineering

Specialization in Computational Physics

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Stochastic Modelling and Simulation	INF/01	B	6	II
Advanced Numerical Analysis	MAT/08	B	6	II
Optimisation Models	MAT/09	B	9	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Computational Physics Laboratory	FIS/01	C	6	II
At least 6 CFU (TAF C) between				
Molecular Simulation	ING-IND/24	C	9	I
Fluid Dynamics	ICAR/01	C	6	I
At least 12 CFU (TAF D) between				
Numerical Methods in Quantum Mechanics	FIS/03	D	6	II
Simulation of Multibody Systems	FIS/03	D	6	II
Physics of Atmosphere	FIS/06	D	6	II
Computational Quantum Chemistry	CHIM/02	C	6	II
Fluid Dynamics	ICAR/01	C	6	I
Molecular Simulation	ING-IND/24	C	9	I
Statistical Mechanics	CHIM/02	D	6	I
Software Development Methods	ING-INF/05	C	6	I

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Computational Science and Engineering

Specialization in Computational Cosmology

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Stochastic Modelling and Simulation	INF/01	B	6	II
Advanced Numerical Analysis	MAT/08	B	6	II
Optimisation Models	MAT/09	B	9	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Astrophysics	FIS/05	C	6	I
Formation of Cosmological Large-Scale Structures	FIS/05	C	9	I
Introduction to Cosmology	FIS/05	F	1	I
Theoretical Astrophysics	FIS/05	D	6	I
At least 6 CFU (TAF D) between				
Computational Physics Laboratory	FIS/01	C	6	II
Simulation of Multibody Systems	FIS/03	D	6	II

This specialization is recommended only to students with a bachelor in Physics.

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Computational Science and Engineering

Specialization in Computational Chemistry

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Stochastic Modelling and Simulation	INF/01	B	6	II
Advanced Numerical Analysis	MAT/08	B	6	II
Optimisation Models	MAT/09	B	9	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Computational Physics Laboratory	FIS/01	C	6	II
Computational Quantum Chemistry	CHIM/02	C	6	II
Molecular Simulation	ING-IND/24	C	9	I
At least 6 CFU (TAF D) between				
Numerical Methods in Quantum Mechanics	FIS/03	D	6	II
Simulation of Multibody Systems	FIS/03	D	6	II
Statistical Mechanics	CHIM/02	D	6	I
Software Development Methods	ING-INF/05	C	6	I

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

Curriculum: Computational Science and Engineering

Specialization in Control and Design of Cyber-Physical Systems

I Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	I+II
Foundations of High Performance Computing	ING-INF/05	B	9	I
Machine Learning and Data Analytics	ING-INF/05 SECS-S/01	B C	6 6	I
Numerical Analysis	MAT/08	B	6	I
Stochastic Modelling and Simulation	INF/01	B	6	II
Advanced Numerical Analysis	MAT/08	B	6	II
Optimisation Models	MAT/09	B	9	II

II Year

Course	*SSD*	*TAF*	*CFU*	*SEM*
Systems and Control Theory	ING-INF/04	C	9	I
Optimal and Robust Control	ING-INF/04	C	9	II
Cyber-Physical Systems	INF/01	C	6	II
At least 6 CFU between				
Optimisation and Design	ING-IND/08	C	6	I
Statistical Machine Learning	INF/01	C	6	II
Software Development Methods	ING-INF/05	C	6	I

ANNEX C: EDUCATIONAL OBJECTIVES

ING-INF/05 - Advanced Programming and Algorithmic Design - 12 CFU
Objective: providing advanced knowledge of both theoretical and practical programming in C / C ++ and Python, with particular regard to the principles of object oriented programming and best practices of software development (advanced use of version control systems, continuous integration, unit testing), and introducing the modern technology of algorithms development, in particular of parallel algorithms.

ING-INF/05 - Foundations of High Performance Computing - 9 CFU
Objective: introducing students to modern architectures for high performance computing. Students will learn how to properly test such architectures (computing power, bandwidth, latency, energy efficiency). Leveraging these skills, students will be introduced to the parallel programming based on MPI protocols (Message Passing Interface) and multi-threading with OpenMP.

ING-INF/05+SECS-S/01 - Machine Learning and Data Analytics - 6+6 CFU
Objective: introducing students to the principles of data analysis, to data mining, aand to machine learning (supervised and unsupervised learning).

MAT/08 - Numerical Analysis - 6 CFU
Objective: providing numerical analysis tools for scientific computing, with particular attention to linear algebra, polynomial approximation, numerical integration, numerical solution of ordinary differential equations and partial differential equations, approximation of eigenvalues and eigenvectors.

INF/01 - Stochastic Modelling and Simulation - 6 CFU
Objective: introducing students to the fundamentals and practice of stochastic modeling, simulation of stochastic models and inference of parameters starting from observations, with a focus on scalability for large models.

MAT/08 - Advanced Numerical Analysis - 6 CFU
Objective: introducing the student to state of the art methods for the numerical simulation of partial differential equation.

MAT/09 - Optimisation Models - 9 CFU
Objective: providing students with the methodological, theoretical and practical tools to formulate linear programming models and combinatorial optimization problems and to solve them, even for high dimensionality problems, using appropriate optimization software.

INF/01 - Data Management for Big Data - 9 CFU
Objective: introducing students to computational management of data, in particular the characterization of an information system, data modeling, design and management of databases, including non-traditional ones (eg, unstructured documents, spatial data, biological data , multimedia data), to the fundamentals of distributed data and to methodologies and techniques for the management and analysis of big data.

SECS-S/01 Statistical Methods for Data Science - 6 CFU
Objective: presenting the basic elements and principles of inferential statistics and statistical techniques for the analysis of complex data.

INF/01 - Statistical Machine Learning - 6 CFU
Objective: presenting advanced machine learning techniques, with a focus on deep learning and Bayesian methods.

UNIVERSITÀ
DEGLI STUDI DI TRIESTE

ANNEX D: EQUIVALENCE OF ENGLISH CERTIFICATES

MINIMAL LEVEL REQUIRED = B2

Examinations Board / Examinations	**Common European Framework of Reference for Languages (CEFR)**		
	B2	**C1**	**C2**
Cambridge English Language Assessment (Cambridge ESOL Examinations)	FCE First Certificate in English	CAE Certificate in Advanced English	CPE Certificate of Proficiency in English
	BEC Business English Certificate Vantage	BEC Business English Certificate Higher	
	BULATS Business Language Testing Service Upper Intermediate 60 - 74	BULATS Business Language Testing Service Advanced 75 - 89	BULATS Business Language Testing Service Upper Advanced 90 - 100
IELTS (International English Language Testing)	5.5 - 6.5	7.0 - 8.0	9.0
City & Guilds (Pitman)	ESOL Communicat	ESOL Expert	ESOL Master
Trinity College London	ISE II ISE II Ca' Foscari	ISE III ISE III Ca' Foscari	ISE IV
	Grades 8 - 10	Grade 11	Grade 12
ETS - TOEFL (Test of English as a Foreign Language)	iBT 87 - 109	iBT 110 - 120	
	PBT 507 - 557	PBT 560 - 617	PBT 620 - 677
Oxford University Press Oxford Test of English B	score 111-140		

ETS - TOEIC (Test of English for International Communication)	Listening 400- 489 Reading 385-454 Speaking 160-199 Writing 150-	Listening 490 Reading 455 Speaking 200 Writing 200	
Pearson Tests of English	PTE General 199 Level 3	PTE General Level 4	PTE General Level 5
	PTE Academic 59 - 75	PTE Academic 76 - 84	PTE Academic 85
LCCI International	JETSE T Level 5	JETSE T Level 6	JETSE T Level 7
	English for Business Level 3	English for Business Level 4	
Qualifications - EDI	ELSA Advanced High 413 - 441	ELSA Superior 442 - 457	ELSA 458 - 500
British Institutes	B2 vantage: First examination	C1 proficiency: English Diploma Operational	C2 mastery: Master in English Language