PhD School in Space Sciences, Technologies and Measurements

Scuola di Dottorato in "Scienze Tecnologie e Misure Spaziali (STMS)"

University of Padua - Italy

School Specifications and Program for 2013
(23 November 2012)

Foreword

This Document describes the School composition, activities, structure and resources foreseen in 2013.

This Document is yearly updated by the PhD School Boards. It serves as a guide to facilitate teachers and doctoral students. Its content is meant to be applied without rigidity, with the only requirement to fully satisfy the main goals of the School, namely to provide excellence in education and formation. Variations to what here written are possible under acceptance of the School Boards, always staying within the limitations foreseen by the Academy and School Rules.

Doctoral students follow the indications given in the Document corresponding to the year of enrollment, unless differently stated by the School Boards.

Additional general information about Padova University PhD School (Call, Rules, help, ...) can be found at the following web site: http://www.unipd.it/ricerca/dottorati-di-ricerca.

Contents

1 School Rationale

The main purpose of the Space Sciences, Technologies and Measurements (hereafter STMS) PhD School is the formation of Research Doctors able to realize research in disciplines connected with Sciences, Technologies and Measurements for Space with a broad vision of the respective problematic. The doctoral students usually operate within defined programs and experiments of interest for the School Curriculum research subjects, acquiring wide and interdisciplinary knowledge, learning methodologies and techniques.
The educational process shall enable students to acquire skills and credits toward a University career, and/or a position in other Research Institutes, or Industries. It should also stimulate the potential capabilities of the doctoral student to induce a fall-out of his/her knowledge in the territory, to stimulate the growth of high tech spin-offs, to improve local industry's ability to compete in the wider national and international scenario.
A corollary of the above approach is the formation of Research Doctors capable to raise to leadership levels in scientific and/or industrial programs.

The School derives from merging two previous PhD courses, *Space Sciences and Technologies*, and *Mechanical Measurements for Engineering*, that has enlarged the capability of the School to satisfy its ambitious vision.

The usefulness of mechanical measurements in space sciences and technologies stems from the following considerations:

- every space mission is based on the realization of a number of physical models on which campaigns of measurements aimed to verification and qualification of the unit are performed
- the interpretation of results and their applicability to the flight model is deeply tied to mechanical measurements
- methodologies for instrument design and test require measurements of testing facilities and instrumentation, plus calibration of devices, avionics and instrumentation itself
- robotics for orbital servicing and planetary exploration requires the measurement of various environmental quantities, trajectory planning and process control

Concerning the utility of space sciences and technologies in the field of mechanical measurements, it is evident that a space mission always gives the opportunity to test new and innovative methodologies of measuring in harsh environments. Such methodologies actually can be used in applications other than space, for instance:

- characterization of temperature sensors with high dynamical output
- machine diagnostics
- vision system for measuring and control
- innovative application of laser vibrometry
- deformation measurement without contact
- measuring techniques for diagnostics and quality control
- no contact torque measuring techniques on engines and operative machines
- measuring techniques of contact pressure distribution
- piezoresistive sensor characterization
- opto-mechanical sensors for measuring mechanical quantities in medicine
- innovative measuring techniques for diagnostics in rotating shaft and metal tube
- Bragg fibre sensor characterization
- Clinical diagnostics

2 Departments

The University Institution of reference for the STMS PhD School is the Center of Studies and Activities for Space (in Italian, Centro Interdipartimentale di Studi e Attività Spaziali, hereafter CISAS) "G. Colombo", for administration.
For any information relative to the STMS PhD School, the reference person is Mrs Federica Sannito.

2.1 Interested Departments

Other Departments involved in the STMS PhD School are:

University of Padova, members of CISAS.
Departments of: Physics and Astronomy, Industrial Engineering, Civil and Environmental Engineering, Geosciences, Information Engineering;

Members of the Consortium within the Curriculum of Mechanical Measurements for Engineering and Space
Departments of Industrial Engineering (University of Perugia), Mechanical and Industrial Engineering (University of Brescia), Mechanical Engineering (Polytechnics of Marche), Mechanical and Aeronautics Engineering ("Sapienza" University of Rome), Mechanical and Structural Engineering (University of Trento);

Through letters of intent
- Department of Pure and Applied Mathematics (University of Padova), Department of Mechanical and Industrial Engineering (University of Rome-3).

2.2 International Agreements

The STMS PhD School has a convention with the "Astrophysique et Techniques Spatiales" PhD School of the Université Denis Diderot (Paris-7) for the joint release of the PhD title.
Since 2006 a Protocol of agreement is active with the Ecoles Doctorales de l'Ile-de-France for a joint title in "co-tutelle".
Since December 2010 the STMS PhD School is included in the international network IDPASC (International Doctorate Network in Particle Physics, Astrophysics and Cosmology, http://www.idpasc.lip.pt/).

3 Academic Disciplines and Scientific Areas

The academic disciplines relevant for the STMS PhD School are (University Ministry codes):

FIS/01: Experimental Physics
FIS/05: Astronomy and Astrophysics
GEO/10: Geophysics of the Solid Earth
ING-IND/04: Aerospace Constructions and Structures
ING-IND/05: Aerospace Plants and Systems
ING-IND/12: Mechanical and Thermal Measurements
MAT/07: Mathematical Physics

The main scientific area relevant for the STMS PhD School is (University codes):

10: Industrial Engineering

Other scientific areas of interest for the School are:

1: Mathematical Sciences
2: Physical Sciences
5: Earth Sciences
11: Information Technologies
17: Psychological Sciences

4 Curricula and Fields of Expertise

In order to provide not only a broad, interdisciplinary vision, but also a specific competence in particular fields, two main Curricula (in Italian, Indirizzi) have been instituted in the STMS School, each one with its own educational program:

- Mechanical Measurements for Engineering and Space (in Italian, Misure Meccaniche per l'Ingegneria e lo Spazio, MMIS)
- Sciences and Technologies for Aeronautics and Satellite Applications (in Italian, Scienze e Tecnologie per Applicazioni Satellitari e Aeronautiche, STASA)

The rationale of the distinction in two main Curricula can be appreciated both from the specific disciplines and from their characterization.

4.1 Fields of Expertise of the MMIS Curriculum

- Analysis and definition of measuring methodologies and data processing
- Functional analysis of instrumentation and representation through general theory
- Definition of methods to evaluate the uncertainty
- Innovative procedures for measuring by means of non conventional methods
- Measurements of time variable phenomena with on-line data processing and industrial process monitoring
- Methods to validate interpretative models in industrial and clinical diagnostics
- Industrial installation and equipment testing with the design of optimal measuring system
- Measuring techniques in clinical diagnostics
- Design and setup for laboratory experiments simulating harsh environmental conditions
- Mechanical system testing; development, acceptance and qualification tests
- Design and set up of measuring and testing devices for opto-mechanical and ultrasonic instrumentations

4.2 Fields of Expertise of the STASA Curriculum

- System Engineering and Mission Analysis
- Structural and thermal analysis of Space Systems
- Advanced Robotics; Mechanisms and Tethers in Space
- Dynamics of Space Flights and Attitude Control
- Space Navigation
- Photon Detectors from soft-X rays to near infrared
- Optics and Scientific Instruments for Space
- Physics of Planets, Moons, Comets, Asteroids
- Mission analysis for Universe and Earth Observations
- Interaction between Spacecraft and Space Environment
- Design, verification and test of laboratory simulation in harsh environment
- Neurosciences and comparative psychology for space applications

5 School Governing Bodies

According to Art. 9 of the University Regulations for PhD schools (in Italian, Regolamento di Ateneo), the following School governing bodies have been instituted:

a) the Director, who nominates his Deputy Director
b) the Steering Committe (“Consiglio Direttivo”)
c) the Schoold Board (“Collegio della Scuola”), which is further subdivided in two Curriculum Boards (“Collegio di Indirizzo”), one for STASA and one for MMIS Curricula, each with its own Coordinator and Deputy Coordinator
d) the Scientific Committee (“Comitato Scientifico”)

Their composition and capacities are specified by the University Regulations document (Art. 10, 11, 12, 13 and 14), and by the specific School’s Regulations (in Italian, Regolamento della Scuola).

The present composition of the governing bodies is the following:

Director: Prof. Giampiero Naletto
Deputy Director: Prof. Cesare Barbieri

Steering Committee:

1	Barbieri Cesare	Dean Deputy Director	cesare.barbieri@unipd.it
2	Caporali Alessandro	CISAS Representative STASA Deputy Coordinator	alessandro.caporali@unipd.it
3	Debei Stefano	MMIS Curriculum Coordinator	stefano.debei@unipd.it
4	Francesconi Alessandro	DII Representative	alessandro.francesconi@unipd.it
5	Fulchignoni Marcello	Ecole doctorale Ile-de-France (F) Representative	marcello.fulchignoni@obspm.fr
6	Lancini Matteo	Universities in the MMIS consortium Representative	matteo.lancini@unibs.it
7	Lorenzini Enrico	MMIS Deputy Coordinator	enrico.lorenzini@unipd.it
8	Naletto Giampiero	Director STASA Curriculum Coordinator	giampiero.naletto@unipd.it
9	Rossi Gianluca	Universities in the MMIS consortium Representative	gianluca@unipg.it
10*	Polito Vanessa	STASA Student Representative	Vanessa.polito@virgilio.it
11*	Lucca Fabris Andrea	MMIS Student Representative	andrea.luccafabris@gmail.com

* advisory function, until 31 December 2012

MMIS Curriculum Board:

1	Angrilli Francesco	Expert	
2	Bettanini Carlo Padova, Dip. Ingegneria Industriale	Expert	
3	Cappa Paolo “Sapienza” Università di Roma, Dipartimento di Ingegneria Meccanica e Aerospaziale	Full Professor	ING-IND/12
4	Carlsson Johan University of Wisconsin	Expert	

5	Castellini Paolo Politecnica Delle Marche, Dip. Meccanica	Associate Professor	ING-IND/12
6	Cocuzza Silvio Padova, CISAS	Expert	
7	Debei Stefano Padova, Dip. Ingegneria Industriale	Associate Professor	ING-IND/12
8	De Cecco Mariolino Trento, Dip. Ingegneria Meccanica e Strutturale	Associate Professor	ING-IND/12
9	Del Prete Zaccaria "Sapienza" Università di Roma, Dipartimento di Ingegneria Meccanica e Aerospaziale	Full Professor	ING-IND/12
10	Garinei Alberto Univ. Telematica "G. Marconi"	Associate Professor	ING-IND/12
11	Lancini Matteo Brescia, Dip. Ingegneria Meccanica	Researcher	ING-IND/12
12	Lorenzini Enrico Padova, Dip. Ingegneria Industriale	Full Professor	ING-IND/12
13	Manente Marco Padova, Dip. Ingegneria Industriale	Expert	
14	Moschioni Giovanni Milano, Politecnico	Associate Professor	ING-IND/12
15	Pelaez Jesus Università di Madrid	Professor	
16	Rossi Gianluca Perugia, Dip. Ingegneria Industriale	Full Professor	ING-IND/12
17	Marco Pertile	Expert	
18	Sanmartin Juan Università di Madrid	Professor	
19	Marcello Vanali Milano, Politecnico	Associate Professor	ING-IND/12
20	Zaccariotto Mirco Padova, Dip. Ingegneria Industriale	Researcher	ING-IND/04
21*	Lucca Fabris Andrea	MMIS Student Representative	

* advisory function, until 31 December 2012

STASA Curriculum Board:

1	Barbieri Cesare Padova , Dip. Fisica e Astronomia	Full Professor	FIS/05
2	Bisello Dario Padova , Dip. Fisica e Astronomia	Full Professor	FIS/01
3**	Caporali Alessandro Padova, Dip. Geoscienze	Full Professor	GEO/10
4	Casotto Stefano Padova, Dip. Fisica e Astronomia	Researcher	FIS/05
5	Riccardo Claudi Padova, INAF OAPD	Researcher	FIS/05
6	Cremonese Gabriele Padova, INAF OAPD	Researcher	FIS/05

7	Da Deppo Vania Padova CNR-IFN	Researcher	FIS/05
8	Francesconi Alessandro Padova, Dip. Ingegneria Industriale	Researcher	ING-IND/05
9	Galvanetto Ugo Padova, Dip. Civile, Edile e Ambientale	Full Professor	ING-IND/04
10	Guzzo Massimiliano Padova, Dip. Matematica	Associate Professor	MAT/07
11	Marzari Francesco Padova, Dip. Fisica e Astronomia	Researcher	FIS/05
12	Naletto Giampiero Padova, Dip. Ingegneria dell'Informazione	Associate Professor	FIS/01
13	Pavarin Daniele Padova, Dip. Ingegneria Industriale	Researcher	ING-IND/05
14	Pelizzo Maria-Guglielmina Padova CNR-IFN	Researcher	FIS/03
15	Poletto Luca Padova CNR-IFN	Researcher	FIS/03
16	Paola Zuppella Padova CNR-IFN	Researcher	FIS/03
17*	Vanessa Polito	STASA Student Representative	

* advisory function, until 31 December 2012

Scientific Committee:

1	Roberto Battiston	Univ. Perugia	Dipartimento di Fisica Via A. Pascoli 06123 Perugia r.battiston@tiscali.it	Professor
2	Jean Pierre Bibring	Univ. Paris Sud XI-IAS Orsay	Institute Astrophysique Spatiale IAS Batiment 121, 91405 Orsay Cedex, F bibring@u-psud.fr	Professor
3	Pierre Encrenaz	Univ. Paris VI Pierre et Marie Curie	Observatoire de Paris, Laboratoire LERMA 61 avEnue de l'Observatoire, F-75014 Paris pierre.encrenaz@obspm.fr	Professor
4	Roberto Somma	Thales Alenia Space	roberto.somma@thalesaleniaspace.com	Consultant for relations with academy

6 Main research topics of the School

6.1 MMIS Curriculum

- Diagnostics and reliability assessment of machines and structures
- Innovative methods of measurements in fluids
- Measurements for aerospace systems
- Measuring techniques in clinical and biomechanic diagnostics
- Innovative methods for mechanical and thermal measurements

6.2 STASA Curriculum

- Observations and Exploration of Solar System and Universe
- Space Systems
- Satellite Navigation
- Optics and Space Instruments
- Observation of Earth from Space

7 Training Project

The standard duration of the PhD activity is three years. The PhD title is obtained having overall acquired 180 ECTS (European Credit Transfer and Accumulation System[1]) credits, and having conducted research activities with original contributions. In this document we adopt the equivalence of the Ministry of Education for International Doctorate which foresees 1 ECTS credit = 25 working hours (it is usually considered that there are 1,500 working hours in a year).
It is also assumed, in order to quantify the commitment to training the student, the equivalence between the ECTS credit and the university credit (CFU).
These credits are allocated according to the following scheme:
• 30 ECTS credits in three years for *education*: this includes lectures, courses and seminars, plus hours of study, participation to schools, courses and congresses, and generally all the activities foreseen in Art. 19 of the University Rule document
• 150 ECTS credits for *research*, culminating in the PhD thesis.

7.1 Education

Training formation is divided into educational activities common to all students (interdisciplinary courses) and in educational activities dedicated to each Curriculum.

7.1.1 Interdisciplinary education

In the following there is the list of the interdisciplinary modules, common to both STASA and MMIS Curricula, activated by the School, as well the relative exam procedures. All the lectures, unless otherwise indicated, are held at CISAS.
Changes to the program provided by the School may be requested by the student, and must be approved by the Curriculum Coordinator.

7.1.1.1 Interdisciplinary courses

The interdisciplinary courses proposed by the School are nine modules of 10 hours of lectures each. Given the variety of university education of the School students and the cultural diversity of the two school Curricula, eight of the nine interdisciplinary modules are grouped into two "transversal" courses of four modules each. These two courses aims to provide doctoral students the basic training on the key issues related to the school and presumably not detailed during their pre-doctoral education: one of the two courses is dedicated to doctoral students which are engineering graduated, and the other to the doctoral students which are not engineering graduated. The ninth module is intended for all students, regardless of the type of university education.
The interdisciplinary modules activated by the school are listed below. For every hour of lecture 5 hours of study are assumed, so each module is equivalent to (10+50) / 25 = 2.4 ECTS credits. The module syllabi are shown in Appendix 10.1.

Interdisciplinary course for *engineering graduated* students

- Module 1: Astronomical observations (Prof. Barbieri)
- Module 2: Physics and effects of space environment (Prof. Marzari)
- Module 3: Scientific satellite instrumentation (Prof. Naletto)
- Module 4: Radiation detectors (Prof. Poletto)

Interdisciplinary course for *not-engineering graduated* students

[1] ECTS is based on the convention that 60 credits measure the workload of a full-time student during one academic year. The workload of a full-time study program in Europe amounts in most cases to 36/40 weeks per year and in those cases one credit stands for workload variation from 24 to 28 hours a week. The workload refers to the time in which it is believed that an average student can achieve the required learning outcomes.

- Module 1: Fundamentals of measurements for engineering (Prof. Debei)
- Module 2: Fundamentals of space systems (Prof. Francesconi)
- Module 3: Fundamentals of Aerospace Instrumentation (Prof. Lorenzini)
- Module 4: Measurement systems for diagnostics and control (Prof. Rossi)

Interdisciplinary module for *all students*
- Preparation of a research proposal (Prof. G. Naletto)

Students must normally follow all the four modules foreseen in the interdisciplinary course relevant to their pre-doctoral training, in addition to the common module, and pass the related exams. Students are however invited to attend all the interdisciplinary modules to expand their basic knowledge. Attending a module without doing the exam allows the acquisition of a number of credits corresponding to the hours of frequency only and not of study (10 hours: 10/25 = 0.4 ECTS credits). Students must indicate in their personal training plan (see section 7.1.3) which modules they intend to attend, on which they intend to make the exam, and they should also indicate the approximate period (month of the year) in which they plan to make it.
In case a student had already acquired analogous basic concepts during their pre-doctoral formation, the student may choose not to attend some of the modules provided in the relative interdisciplinary course. In such a case, the student will have to attend another interdisciplinary module (of the other course), and to make the relative exam. These and any other proposed changes to the training program should be highlighted in the student training plan (see section 7.1.3) and must be approved by the Curriculum Coordinator.

Lessons on the same subjects can also be attended in other universities, with permission of the Curriculum Coordinator. In special cases (for example in case of a prolonged stay abroad), a doctoral student may be exempted from attendance at lessons, or at some of them; however, the student has anyway to pass the relative exams. Attendance at these courses which are not activated by the School, as well passing the related exam, must be properly documented by the teacher of the course: the teacher has to sign the doctoral student record book and has to fill in the “Passed exam” form in Appendix 10.2 (the filled form must be delivered by the student to the School Secretary).

In addition to the courses listed above, students will be suggested to attend at seminars on topics of interest for the School. Attendance at these seminars will be counted in the calculation of ECTS credits (1 hour seminar equal to 1/25 ECTS credit). To validate these credits, the seminar speaker has to sign the student record book.

The number of ECTS credits typically achieved with mandatory interdisciplinary modules is 5×2.4 = 12, to which credits achieved with attendance at other modules and seminars have to be added. If the total number of ECTS credits acquired for interdisciplinary activities is lower than 12, the student must adequately compensate with a higher number of ECTS credits in dedicated Curriculum education activities.

7.1.1.2 Interdisciplinary module exams

Students must pass the exams of four interdisciplinary modules (at least two within the end of the first year). The exam typically consists of a colloquium with the teacher on the module topics, or of discussing a project work (“tesina”) prepared by the student on a specific topic of the module. In the latter case, the project work must be carried out in accordance with the teacher and must be delivered to the teacher at least two weeks before the discussion. The type of exam, which can anyway be different from those here described, is decided by the teacher and will be communicated to the students.
The exam on "Preparing a research proposal" module may consist in the actual preparation of an application for funding, for example along the lines of University Calls for Young Researchers, or of ESA Calls for the Rexus/Bexus Programs, or also more challenging calls. This exam can be done in group, involving more doctoral students on the same proposal. It can also be considered the possibility of an effective

application of the proposal to a call for funding, in which case, the submission of the proposal must be previously agreed with the student supervisor.
The positively passed exams must be validated by the teacher responsible of the module, signing the student record book and filling in the "Passed exam" form (see Appendix 10.2); the filled form must be delivered by the student to the School Secretary.
For the admission to the third year, all the exams on the interdisciplinary modules must be completed within the second year of PhD; derogations may be granted by the CdI in special cases such as prolonged staying abroad.

7.1.1.3 Other interdisciplinary activities

Students may participate, after having informed the School Board, to the ESA Rexus/Bexus Programs, as this activity is extremely educational. In this case, the doctoral student acquires 6 ECTS credits, which can be used as an alternative or complement to other interdisciplinary activity.
Students, if willing, can attend the English courses activated by the University Language Centre (http://www.cla.unipd.it/cetest-firstpage/corsi-a-pagamento/inglese-diy/), since it is considered fundamental for a student of this School an excellent knowledge the English language. The courses will be partially funded (half the cost) by the School. Only the course frequency will be considered in the student credit account.
Foreign students can attend the "Italian for foreigns" courses activated by the University Language Centre (http://www.cla.unipd.it/cetest-firstpage/corsi/italiano-per-stranieri/italian-language-courses/). Also these courses will be partially funded (half the cost) by the School. This course, however, is not considered valid in for credit acquisition.
The STEPS (Seminars Towards Enterprise for Ph.D Students) course activated by the University of Padova in collaboration with Camera di Commercio I.A.A. of Padova, Gruppo Giovani Imprenditori di Confindustria Padova and Fòrema Scarl is one of the University interdisciplinary courses dedicated to doctoral students. The School admits the frequency to this course in the student credit account.

The following events, to which the students are always expected to attend, are considered part of the interdisciplinary education. For any participation/presentation, students will obtain credits as indicated
- Presentation by the students admitted to the School of the proposed research program (1/6 ECTS credit for attendance; 1/3 ECTS credit for presentation).
- Presentation by all the students of the activities done during the year (for first and second year students), or of the activity of the three years (for third year students) (0.5 ECTS credits for each event)

Presentations for admission to the third year and to the final exam (or extension request) must be made in English.

In summary, each student typically acquires 14 ECTS credits for interdisciplinary activities as follows:
- 12 ECTS credits for attendance and study of courses and seminars
- 2 ECTS credits for presentations and participation in events

7.1.2 Curriculum dedicated educational activities

In the following, the courses specific for the two Curricula, MMIS and STASA, are indicated; doctoral students will choose which course to attend to obtain ECTS credits. Also the exam prescriptions are indicated.
Curriculum dedicated courses are activated annually by the school when a sufficient number (usually greater than 2) of doctoral students requests it. In case a course is not activated because the number of interested students is too low, they will be informed and will have to choose alternative dedicated educational activities. Doctoral students must choose and follow at least two of the below listed courses, taking into account that the School courses must have priority with respect to other Curriculum specific training activities.
Courses with syllabus similar to those listed above can be attended as an alternative to those activated by the School also in other universities, for example in case of off-site doctoral students, with permission of

the Curriculum Coordinator. In exceptional cases, with the permission of the Curriculum Coordinator, a doctoral student may be exempted from lecture attendance; however, the obligation of study and exam will remain. The Curriculum Coordinator will determine the number of credits to be awarded to the student in such cases.
Changes with respect to the program of School provided Curriculum dedicated educational activities may be requested by the student, and have to be approved by the Curriculum Coordinator.

7.1.2.1 Courses dedicated to the MMIS Curriculum

The following courses dedicated to the MMIS Curriculum can be activated by the School if an adequate number of doctoral students will require it. These are 20 hour courses which correspond, including 5 hours of study for each hour of lecture, to (20 +100) / 25 = 4.8 ECTS credits. The course syllabi are described in Appendix 10.1:

- Introduction to space robotics (Prof. F. Angrilli)
- Biomechanical measurements (Prof. Cappa, held at "Sapienza" University of Rome)
- Measurements of size and motion with vision systems (Prof. P. Castellini, held at Pol. Marche)
- Dynamics and control of free-flying robotic systems for space applications (Prof. S. Cocuzza)
- Temperature measurements in hostile environment (Prof. S. Debei)
- Characterization and measurement techniques for biological and engineered tissues (Prof. Z. del Prete)
- PC-based measurement system development and management (Prof. M. Lancini)
- Airport acoustics (Prof. Moschioni, held at Milan Pol.)
- Measurements with vision systems and LIDAR sensors (Ing. M. Pertile)
- Non contact measurement of stress, strain and dnamical mechanical analysis (Prof. G. Rossi, held at the University of Perugia)
- Sensors and transducers for clinical and biomechanical measurements (Prof. Steindler, Prof. Del Prete and Prof. Hood, held at "Sapienza" University of Rome)
- Structure vibration (Prof. Vanali, held at Milan Pol.)

Each student must attend at least two of these Curriculum dedicated courses, equivalent to 9.6 ECTS credits.

7.1.2.2 Other MMIS Curriculum courses

For his/her specific training, a doctoral student can also choose University courses and/or modules relative to the chosen Curriculum. These courses must be approved by the Curriculum Coordinator.
The following undergraduate courses, if chosen by a doctoral student of MMIS Curriculum, do not require approval:

- Instrumentation and transducers for mechanical measurements (Prof. S. Debei)
- Astrodynamics (Prof. E. Lorenzini)
- Aerospace instrumentation (Prof. E. Lorenzini)

For University courses the correspondence between CFU and ECTS credits is assumed.
STASA Curriculum dedicated courses are also suitable for MMIS specific education, with no need for approval.

7.1.2.3 Courses dedicated to the STASA Curriculum

The following courses dedicated to the STASA Curriculum can be activated by the School if an adequate number of doctoral students will require it. These are 20 hour courses which correspond, including 5 hours of study for each hour of lecture, to (20 +100) / 25 = 4.8 ECTS credits. The course syllabi are described in Appendix 10.1:

- Measuring systems for the thermal and attitude control for aerospace applications (Prof. C. Bettanini)
- Environment effects on the detectors (Prof. D. Bisello)
- In orbit satellite tracking and orbit determination (Prof. A. Caporali)
- Orbital dynamics (Prof. S. Casotto)
- Optical design (Prof. V. Da Deppo)
- Orbit and attitude control (Prof. R. Da Forno)
- Mechanics of composite materials (Prof. U. Galvanetto)
- Techniques for dynamic analysis in Hamiltonian systems and applications (Prof. M. Guzzo)
- Geology and exploration of terrestrial planets (Prof. M. Massironi / Prof. G. Cremonese)
- Aerospace propulsion (Prof. D. Pavarin, Prof. M. Manente)
- Optical coating and multilayer structures (Prof. M.-G. Pelizzo)
- Thermo-mechanical instrumentation for space applications (Prof. M. Zaccariotto)

Each student must attend at least two of these Curriculum dedicated courses, equivalent to 9.6 ECTS credits.

7.1.2.4 Other STASA Curriculum courses

The participation to the National School on "Detectors and Electronics for High Energy Physics, Astrophysics, Space Applications and Medical Physics", which is held every two years at the National Laboratories of Legnaro (http://sirad.pd.infn.it/scuola_legnaro) is automatically recognized as specific training activity. Doctoral students following this National School acquire ECTS credits as indicated in section 7.1.2.6.

For his/her specific training, a doctoral student can also choose University courses and/or modules relative to the chosen Curriculum. These courses must be approved by the Curriculum Coordinator.
The following undergraduate courses, if chosen by a doctoral student of STASA Curriculum, do not require approval:

- Elements of astronomy and astrophysics (Prof. C. Barbieri)
- Industrial applications of ionizing radiation sources (Prof. A. Candelori)
- Theory of orbits (Prof. S. Casotto)
- Comets and small bodies (Prof. M. Lazzarin)
- Space Optics Instrumentation (Prof. G. Naletto)
- Identification of models and data analysis (Prof. G. Picci)

For University courses the correspondence between CFU and ECTS credits is assumed.
MMIS Curriculum dedicated courses are also suitable for STASA specific education, with no need for approval.

7.1.2.5 Curriculum dedicated course exams

One of the Curriculum dedicated course exam, chosen by the student, finalized to assess the teaching skills of the doctoral student, has to be in the form of an academic lecture of about 30 minutes on a course topic: the lecture has to be structured as if it were addressed to a potential audience of students who need to learn the subject. The lecture has to be described in an analytical and sequential way, properly detailing several aspects to improve the understanding of the subject, or of any complex logical steps; assistive computer tools can be used only if strictly necessary, such as to support the description of complex objects. This exam has to be done by each doctoral student, regardless of the chosen training plan, as it is mandatory to be admitted to the final exam.
The other Curriculum dedicated course exams will be held in the form of project report or otherwise agreed with the teacher. The positively passed exam will be validated by the teacher responsible of the course, which will fill in the “Passed exam” form (see Appendix 10.2) and sign the student record book. The form must be delivered to the School Secretary by the student who has passed the exam.

If a doctoral student attends a university course/module, it is assumed that the student also carries out the relative course exam; in this case, after successfully passing the exam, the course is assigned a number of ECTS credits equivalent to the course CFU's. The exam must be certified by the teacher of the course by signing the student record book and filling in the "Passed exam" form (Appendix 10.2). The completed form must be delivered by the student to the School Secretary.

Some doctoral students have, as their main research task, the extensive development of codes/software packages for a potential distribution to other users, or the integration of routines/software libraries in already existing professional software. In these cases the student has to comply with the standards commonly used for software development. For this purpose, appropriate documentation is available on the School website. These doctoral students will have to demonstrate the understanding of these standards and the application in their software codes by means of a "software review". The software review is an 0optional exam in which these students must properly describe the structure of the piece of software made. The software review (supervised by Prof. Casotto) is dedicated to the students of the third year; this exam involves the acquisition of two ECTS credits.

7.1.2.6 Other Curriculum dedicated educational activities

Doctoral students can dedicate up to 50 hours per year on educational support or on integration to university courses. These activities must be approved by CdS, following the directions of the Academic Bodies. Credits related to teaching support are considered within the Curriculum dedicated educational activities, taking one hour lecture equal to 2/25 ECTS credits (maximum of 4 ECTS credits per year).
Also participating in Schools, Courses and Congresses is considered as Curriculum dedicated formation activity: in this case, one hour of participation is assumed equivalent to 1/25 ECTS credit. Through this activity, each student can achieve up to 2 ECTS credits per year; the allocation of these ECTS credits is subject to the submission to the Curriculum coordinator and to the School Secretary of proper documentation of participation in the School or in Congress.

In summary, each doctoral student gets at least 9.6 ECTS credits for the Curriculum dedicated activities. Considering also the 14 ECTS credits typically achieved for interdisciplinary activities, normally a student acquires at least 23.6 credits in educational activities enabled by the school. The remaining credits needed to reach the 30 ECTS credits for extra research training activities must be achieved by means of activities chosen by the doctoral student, in line with the above given directions.

7.1.3 Personal training plan

During the presentation of the proposed research program (February first year), first year doctoral students must provide a "personal training plan" with the indication of which of the courses that may be activated by the School they wish to follow. They must also include any other educational activity they plan to do, with an indication about the type of activity, the period in which this activity will be carried out and, if possible, how many ECTS credits can be acquired. The template for the personal training plan can be found in Appendix 10.3.
At the end of the attendance of modules/courses of the autumn session of the first year, first year doctoral students must update their personal training plan: they have to specify the period in which they intend to make the exam, the type of exam (if interview, project work, seminar, lecture, etc.), and the relative attainable ECTS credits. At this point, the personal training plan must show the prediction of the attainment of 30 ECTS credits in educational activities during the three years.
The personal training plan should then be updated twice a year (May and November), with the indication of the progress in achievement of ECTS credits in educational activities.
The training plan may be amended, upon approval of the Curriculum Coordinator, until the end of the second year. Any changes to the training plan as foreseen by the School have to be described in the personal training plan, and must be approved by the Curriculum Coordinator.

The recommended distribution of credits achieved for the various educational activities is roughly 15, 12, 3 ECTS credits in the first, second and third year respectively. However, the following minimum number of credits have to be obtained: at least 9 and at least 21 ECTS credits must be achieved in November of first and second year, respectively. A smaller number may lead to the not-admission to the following year. Within June 30 of the third year, all the foreseen ECTS credits for educational activities/training must have been obtained; exceptions are granted only in cases of prolonged suspension justified by the School, or extended staying abroad. It is assumed the participation in a School/Congress at least once in three years.

7.2 Research

Research is the primary instrument of the doctoral training project, to which the student devotes more than 80% of the total workload in the three years of the School. The research product should be innovative and classified in at least one of the following categories: new tools/equipment, new know-how, new processes, new methods, publications, spin-off. In carrying out his/her research, under the tutoring of a supervisor (and, in the case, by a co-supervisor) assigned by the School Board, the doctoral student shall contribute original contents.
Doctoral students are strongly encouraged to spend some time in foreign research institutions, where studying in deep the undergoing research activity. To this end the University has a specific allocated budget to increase the basic PhD grant for periods abroad longer than 20 days. Periods longer than six months have to be approved by the School Board. Here there is a template for the request to the Board:

<<<<The doctoral student *Name Surname* of *NNN* cycle *MMIS/STASA* curriculum asks to the School Board the authorization to spend the period from ... to ... at the *Institute/University* in *City (State)* for making research activities under the supervision of *Name Surname*. The subject of the research during this period will be ..... The doctoral student supervisor, Prof. *Name Surname*, supports this request.>>>>

An invitation (letter or e-mail) by the hosting institution should preferably be attached to the request.

7.3 PhD Thesis

The research realized by the doctoral student is documented by the doctoral thesis. The thesis must describe in an analytical way the research activity, highlighting the original contributions given by the doctoral student.
The supervisor verifies that the thesis is conformal to the foreseen activity program.

7.3.1 Thesis title and research objectives

The research subject of the doctoral thesis is identified since first year, giving it a title and defining its objectives and the international context. Under motivated circumstances, the proposed research may be changed during the first year, even substantially: this has to be agreed with the supervisor and must be approved by the Curriculum Board. In the years following the first, the doctoral thesis can be adjusted with only minor changes, unless exceptional causes arise, and must be approved by the Curriculum Board. The title of the thesis must be determined at the end of the second year; further possible changes to the title must be approved by the Curriculum Board.

7.3.2 Foreign language thesis

The thesis can be written in Italian, in English or other foreign language agreed with the School Board. Since the topics covered in this Doctoral School are often devoted to international scientific research that uses almost exclusively the English language, it is suggested to write the thesis in English.
Please note that, as required by University regulations, to write the thesis in a foreign (not Italian) language is in any case necessary to ask the permission of the School Board (the request must be made at the end of the first year of the PhD).
The thesis, regardless of the language in which it is written, must however contain a section summarizing the work done both in Italian and in English (or the other foreign language indicated by the School Board).

It is required that the summary of the thesis in the secondary language is relatively large (at least 5% of the thesis).

7.3.3 Summary of the doctoral student work

In order to facilitate the evaluation of the thesis by the members of the Final Exam Board, the doctoral student must include in the introductory part of the thesis a less than 3 pages summary indicating the actual contributions made by the student in the totality of the described work. This has to be done with references to the relevant sections, highlighting the original/innovative contributions.

7.3.4 Thesis development

The development of the doctoral thesis must start from the first year of PhD, on the basis of the program of the expected research activities.
For admission to the second year, the doctoral student must submit to the School Board:
- a complete index (content) of the thesis.

For admission to the third year, the student must submit to the School Board:
- a script of the thesis: the latter consists of a structured index, corresponding to the state of the work and to the prediction of future activities, and, for each section of the index, either a preliminary description of what the student will write in, or a draft of the final document.

For the admission to the final exam, the student must submit to the School Board:
- a draft of the thesis: this corresponds to about 50% of the final report, and must include both the summary in the foreseen second language and the summary of the doctoral student work. The supervisor checks that the work adheres to the foreseen program of activities of the student, and ensures that the quality and quantity of the text are appropriate for the current state of research.

7.3.5 Doctor Europaeus

Students who spent at least three months in a European Union country to work on their PhD research activity, may require the obtain the “mention” of Doctor Europaeus.
To achieve this:
- The thesis must be evaluated by at least two professors from two universities in two countries of the European Union other than the one in which the thesis will be discussed and that are not part of the Final Exam Board; their evaluations have to be forwarded to the members of Final Exam Board together with the PhD thesis;
- At least one member of the Final Exam Board must belong to an EU country other than that in which the thesis is discussed;
- Part of the discussion must take place in one of the official languages of the EU other than the country in which the thesis is discussed.

It is important to note that the need for an external audit of the thesis prior to the delivery of the same to the relevant offices implies that the thesis must be substantially completed well in advance of the delivery deadline (typically at least one month before the official date of delivery).

7.3.6 Other suggestions for the thesis editing

In the dissertation should be highlighted, wherever applicable, the topics covered in the interdisciplinary and curriculum dedicated courses, highlighting the connections between what has been learnt in these courses and the possible applications to the thesis topics.
In case dedicated software has been developed, it is desirable to adhere to European standards for appropriate documentation and usability, as already mentioned.

Finally, note that the writing of the thesis typically requires at least 10% of the total commitment for research: it is required that the student provides adequate time for its preparation.

In order to avoid large differences in the layout of the thesis, it is recommended to follow the following standards:
- Font: Times New Roman 11/12 pt (or similar)
- Line spacing: 1 - 1.2 lines
- Margins (A4): 2.5 cm top, 2 cm bottom, 2 cm external, 2/2.5 cm internal

Finally, for additional information, Art. 21 of the University Regulations on Doctoral Thesis is here reported (in Italian).

Art.21 (Tesi di Dottorato: termini e proroga)

1. Al termine di un ciclo triennale di studi e ricerche, il Collegio Docenti esprime un giudizio per ciascun dottorando. Il Regolamento interno della Scuola può prevedere che alla formulazione di tale giudizio concorra anche il parere scritto di uno o più referees esterni. Gli allievi che abbiano conseguito risultati giudicati di rilevante valore scientifico sono ammessi a sostenere l'esame ai fini del conseguimento del titolo di Dottore di Ricerca.

Il Collegio docenti esprime il suddetto giudizio e trasmette al Rettore il relativo verbale entro il 15 dicembre.

2. L'esame finale consiste nella discussione della tesi di Dottorato.

3. La tesi finale potrà essere redatta anche in lingua straniera previa autorizzazione del Collegio Docenti. Essa dovrà comunque contenere una esposizione riassuntiva del lavoro svolto sia in lingua italiana che in lingua inglese o in altra lingua straniera indicata dal Collegio Docenti.

4. Entro il mese successivo alla conclusione dei corsi, i dottorandi ammessi all'esame finale dovranno inoltrare al Rettore domanda di esame finale corredata da:

a) tre esemplari della tesi per il deposito presso l'archivio dell'Ateneo e presso le Biblioteche Nazionali di Roma e di Firenze e un ulteriore esemplare in formato digitale.

b) Copia del verbale del Collegio Docenti con giudizio dell'attività complessiva svolta e ammissione all'esame finale.

Al momento dell'inoltro della domanda di esame finale, i dottorandi dovranno essere in regola con il pagamento delle tasse di iscrizione per i tre anni di corso.

I dottorandi dovranno inoltre inviare, non appena sarà stata loro resa nota la composizione della commissione esaminatrice, una copia della tesi corredata dal giudizio del Collegio Docenti a ciascuno dei componenti della Commissione.

5. Le tesi dovranno essere firmate dal Direttore della Scuola e dal Supervisore.

6. La data e il luogo d'esame verranno comunicati direttamente ai dottorandi e affissi all'albo dell'Università.

7. In caso di mancato superamento, l'esame può essere ripetuto per una sola volta nella sessione successiva.

8. Al candidato che abbia superato l'esame finale verrà attribuito il titolo di dottore di ricerca e verrà in tal senso rilasciato un diploma che riporterà la dicitura della Scuola di Dottorato nonché dell'Indirizzo frequentato.

9. Per comprovati motivi che non consentano la presentazione della tesi nei tempi previsti, il Rettore, previa istanza del dottorando e su proposta motivata del Collegio Docenti può prorogare fino a un massimo di 12 mesi il termine per la presentazione della domanda di esame finale.

Ulteriori proroghe fino ad un massimo di altri 12 mesi possono essere concesse solo per il perdurare di impedimenti gravi. Le proroghe possono essere richieste esclusivamente per periodi di sei o dodici mesi.

10. L'istanza di proroga deve essere inoltrata al Rettore entro il 30 novembre dell'ultimo anno di corso di dottorato. Entro la scadenza della proroga, il candidato deve presentare la domanda di esame finale. Eventuali richieste di ulteriori proroghe dovranno essere inoltrate entro le scadenze annuali del 30 novembre o del 31 maggio.

Sulle richieste di ulteriori proroghe presentate entro il 31 maggio, il Collegio dovrà esprimersi entro il 15 giugno.

11. In caso di mancato rinnovo della Scuola/Indirizzo nel ciclo successivo, il Rettore nomina apposita Commissione con le modalità di cui al successivo art. 23.

12. La proroga non dà titolo alla fruizione della borsa di studio e non comporta alcun onere economico per l'Università degli Studi di Padova, eventuali obblighi di natura assicurativa saranno a carico dell'interessato.

7.4 Research program guidelines

For better planning of activities, and to form a necessary managerial mentality, it is suggested to adhere to the following planning for the thesis development.

- To formulate a research program indicating both the scientific and technical content, and the foreseen amount of commitment (in man-hours, assuming 1500 working hours per year) in the form of Work Breakdown Structure (WBS); the WBS has to be developed at least to the first level for first year doctoral students, and at least to second level for admission to the second year.
- To illustrate the temporal evolution of the program through a GANNT Bar Chart, in agreement with the WBS. In the first year, it is convenient to expand the chart to have visibility on a quarterly basis for the first year, and at least on a six month basis for the other two years. From the second year, all the chart has to be expanded with at least 3 months of temporal resolution.

Below is an example of a program that takes into account theses of 3750 hours in 3 years, divided into quarterly man-hours for each work package (WP) indicated at the first level, and expanded as applicable to the third level.

7.4.1 Example of Work-Breakdown Structure (WBS)

Level			Activity description (WP title)	hours	I year				II year				III year			
1	**0**	**0**		**1060**	**150**	**250**	**250**	**250**	**160**							
	1	0		250	150	100										
		1		100	50	50										
		2		150	100	50										
	2	0		550		150	200	200								
		1		150		100	50									
		2		100		50	50									
		3		100			100									
		4		200				200								
	3	0		260			50	50	160							
		1		100			50	50								
		2		160					160							
2	**0**	**0**		**1070**				**250**	**280**	**300**	**145**	**95**				
	1	0		400				190	140	70						
	2	0		670				60	140	230	145	95				
		1		390				60	140	130	45	15				
		2		280						100	100	80				
3	**0**	**0**		**1070**								**100**	**350**	**350**	**200**	**70**
	1	0		600								100	200	200	100	
	2	0		470									150	150	100	70
4	**0**	**0**	**Writing Thesis and reports**	**550**					**20**	**35**	**50**	**70**	**45**	**80**	**100**	**150**

<u>Note:</u> X00 is a level 1 WP, XY0 is level 2 WP, XYW is level 3 WP. Students beginning the first year should show an analysis at least to level 1; for admission to second year, an analysis to at least level 3 is requested. Note: it is convenient to not exceed with the first level WP (i.e., no more than 9).

7.4.2 Example of WBS description

For each Level 1 WPs, describe in not more than 3 lines their characteristic technical content, in order to justify the sublevels indicated in the WBS.

WP	Technical Description
100	
200	
300	

7.4.3 Example of research program GANNT Bar Chart

Level			Activity Description (WP title) and events	I year				II year				III year			
Event			Presentation for approval of Research	▼											
1	0	0													
	1	0													
		1													
		2													
	2	0													
		1													
		2													
		3													
		4													
	3	0													
		1													
		2													
Event			Admission to II year				▼								
2	0	0													
	1	0													
	2	0													
		1													
		2													
Event			Admission to III year								▼				
3	0	0													
	1	0													
	2	0													
Event			Admission to final examination												▼
4	0	0	Writing Thesis and reports												
Event			Final examination (< April next year)												→

Note: Students entering the first year should present a bar chart at least to level 1 of the WBS; for admission to second year, a B-C at level 3 is requested.

7.5 Miscellanea

Students are invited to consult the website of the university (http://www.unipd.it/ricerca/dottorati-di-ricerca) for information regarding:

- Schools and doctoral courses active
- Thesis
- Register the teaching of the students
- Forms
- Taxes
- Economic benefits
- Accidents at work and occupational diseases (INAIL)
- Living abroad (authorization and increase the scholarship)
- Scholarship (mode of delivery and social security deductions INPS information)
- Ranking regional grants
- E-mail (any doctoral student will be assigned an e-mail address)

8 School Management

8.1 School program management

The program of the School is organized in a series of events which involve both doctoral students and teachers. The following table provides a yearly calendar of the major events.

Event	Period	Presence of doctoral students	Presence of Teachers
Meeting with first year doctoral students	Jan	First year	Director and Curriculum Coordinators
Communication about mobility funds availability	Jan	First year	Director
Doctoral student representative election	Jan	All	Curriculum Coordinators
Presentation first year research programs	Feb	All	School Board and Supervisors
School Board meeting	Feb	Representatives	School Board and Supervisors
Final exam (ordinary session)	Spring	Students admitted to the final exam	Director
Training program update	May	Second and third year students	Curriculum Coordinators
School Board meeting	Jun	Representatives	School Board and Supervisors
Lectures	Jun	Involved students	Involved teachers
Lectures	Sept	Involved students	Involved teachers
English course (http://claweb.cla.unipd.it/cla/DIY.html)	Sept	Involved students	CLA teachers
Training program update	Sept	First year students	Curriculum Coordinators
Final exam (extra session)	Autumn	Students admitted to the final exam (with extension)	Director
Admission exam	October	Candidate students	Director and exam board
Training program update	Nov	All	Curriculum Coordinators
Admissions to 2nd and 3rd year, admissions to final exams	Nov	All	School Board and Supervisors
School Board & Scientific Committee meeting	Nov	Representatives	School Board, Supervisors, members of Scientific Committee

8.1.1 Doctoral student activity program

The activities of each doctoral student are documented by the “Analytical report of the doctoral activities”. This report, which includes the personal training plan, shall be submitted to the School Board: shortly after admission to the School for the approval of the training plan and of the proposed research, and then by the end of the year for the admission to following years and to the final exam. The template of the analytical report is shown in Appendix 10.4.

To be admitted to the second and the third year as well as to the final exam, the doctoral student must also describe the ECTS credits acquired in educational activities by updating the personal training plan (May and November) and the thesis status. In addition, among the criteria to be considered for admission to the next year, also the update by the student of the personal CINECA web site will be considered.

For the admission to the final exam of a doctoral student, the supervisor has to prepare an evaluation form. Once approved by the School Board, it must be attached (unbound) to the copies of the thesis for both the University and the members of the Final Exam Committee. The evaluation form template can be found in Appendix 10.5.

8.1.2 Three-years calendar of the doctoral students major events for verification and approval of educational and research activities

Event	Period	Description and comments
Introductory meeting	Jan I	Presentation of the School by the Director and Curriculum Coordinators
PhD student representative elections	Jan I	
Approval of personal training plan and research proposal	Feb I	At least one week before the meeting of the School Board should be given the documents required for the approval of the training plan and of the proposed research Presentation of the proposed research program
Lectures	Jun I	
Lectures	Sep I	
Update of personal training plan	Sep I	Just after the end of the courses and by the end of the month the students have to deliver to the Curriculum Board the complete personal training plan
Admission to second year	Nov I	All the required documentation for the admission to the second year has to be delivered at least one week in advance the School Board meeting Presentation of the research activity done during the first year
Doctoral student representative election	Jan II	
Update of personal training plan	May II	
Lectures	Jun II	Courses not attended during first year
Lectures	Sep II	Courses not attended during first year
Admission to third year	Nov II	All the required documentation for the admission to the third year has to be delivered at least one week in advance the School Board meeting Presentation (in English or other agreed foreign language) of the research activity done during the second year
Doctoral student representative election	Jan III	
Update of personal training plan	May III	It is required that the minimum number of ECTS credits in educational activities (30) has to be reached within June III
Possible request of Doctor Europaeus "mention" or of extension of thesis delivery	Sep III	
Admission to final exam or to the requested extension period	Nov III	All the required documentation for the admission to the final exam or for the extension has to be delivered at least one week in advance the School Board meeting Presentation (in English or other agreed foreign language) of the research activity done during the PhD period
Delivery of the thesis to the reviewers (for the Doctor Europaeus "mention")	Dec III	The thesis has to be at a suitable level for an international review
Delivery of the student record book and of thesis first page	Dec III	After admission to the final exam, for the signatures of Director and Supervisor
Delivery of evaluation School form	Dec III	
Delivery of the thesis	Jan IV	
Final exam	Spring IV	Thesis discussion with an external Board

Event	Period	Description and comments
For doctoral students requiring extension:		
Possible request of Doctor Europaeus “mention” or of further extension of thesis delivery	Mar IV	
Admission to final exam or to the further extension period	Mag IV	All the required documentation for the admission to the final exam or for the further extension has to be delivered at least one week in advance the School Board meeting Presentation (in English or other agreed foreign language) of the research activity done during the PhD period
Delivery of the thesis to the reviewers (for the Doctor Europaeus “mention”)	Jun IV	The thesis has to be at a suitable level for an international review
Delivery of the student record book and of thesis first page	Jun IV	After admission to the final exam, for the signatures of Director and Supervisor
Delivery of the thesis	Jul IV	
Final exam	Autumn IV	Thesis discussion with an external Board
For doctoral students requiring further extension:		
Possible request of Doctor Europaeus “mention”	Set IV	
Admission to final exam or to the further extension period	Nov IV	All the required documentation for the admission to the final exam or for the further extension has to be delivered at least one week in advance the School Board meeting Presentation (in English or other agreed foreign language) of the research activity done during the PhD period
Delivery of the thesis to the reviewers (for the Doctor Europaeus “mention”)	Dec IV	The thesis has to be at a suitable level for an international review
Delivery of the student record book and of thesis first page	Dec IV	After admission to the final exam, for the signatures of Director and Supervisor
Delivery of the thesis	Jan V	
Final exam	Spring IV	Thesis discussion with an external Board

If a student cannot attend an official event has to apply in advance to the Director (cc-ing the Curriculum Coordinator) to be justified. In cases of absence occurred due to force majeure, the student is required to notify the Director and the Curriculum Coordinator as soon as possible. In particular, an absence during the presentation of research for admission to the following year of the doctorate or to the final exam can be justified only in case of illness or prolonged stay abroad. In these cases, the student supervisor must make a presentation of the activities in behalf of the student.
Participation to classes and modules (mandatory or not) is certified by suitable forms provided and/or by the signatures of the teacher on the student booklet.

8.1.3 Documentation needed for formal approvals

Doctoral students have to provide the following documentation in electronic format to the Curriculum Coordinator, and copy to the Director of the School.

Approval	Required Documentation
Approval of personal training plan and of proposed research	- Analytical report, including personal training plan - Presentation of the proposed research program
Admission to second year	- Updating of the analytical report, approved by the supervisor; it has to include the personal training plan demonstrating the achievement of at least 9 ECTS credits and of passing at least two interdisciplinary course exams - Complete index of the thesis - Declaration of updating the CINECA personal site - Request to write the thesis in English (or other agreed foreign language) - Presentation of the work done in the first year
Admission to third year	- Updating of the analytical report, approved by the supervisor; it has to include the personal training plan demonstrating the achievement of at least 21 ECTS credits and of passing all interdisciplinary course exams; last term for modifications to be approved by the Curriculum Board - Description of thesis structure - Declaration of updating the CINECA personal site - Presentation in English of the work done in the second year
Request of extension	- Updating of the analytical report, approved by the supervisor; it has to include the personal training plan demonstrating the achievement of at least 30 ECTS credits and of passing all foreseen exams - Description of thesis structure - Declaration of updating the CINECA personal site - Presentation in English of the work done in the third year (or of extension period, if any)
Admission to final exam	- Updating of the analytical report, approved by the supervisor; it has to include the personal training plan demonstrating the achievement of at least 30 ECTS credits and of passing all foreseen exams - Draft of the thesis - Declaration of updating the CINECA personal site - Presentation in English of the work done during the PhD

Lack of the required documentation might entail not admission to the final exam and even expulsion from the School.

8.1.4 Supervisor schedule and list of the documentation

Supervisors also are involved in the School activities: their tasks follow the doctoral student activities and the main events are summarized in the following table.

Activities	Period	Required documentation
Approval of the research programs proposed by first year doctoral student	Feb I	Approval of analytical report
Admission of doctoral student to second year	Nov I	Approval of analytical report and of thesis index. Short doctoral student evaluation (max 10 lines e-mail).
Admission of doctoral student to third year	Nov II	Approval of analytical report and of thesis structure description. Short doctoral student evaluation (max 10 lines e-mail).
Proposal of members for final exam Committee	Sep III	

Activities	Period	Required documentation
Admission of doctoral student to final exam	Nov III	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Admission of doctoral student to required 6-month extension period	Nov III	Approval of analytical report and of thesis structure description. Short doctoral student evaluation (max 10 lines e-mail).
Signature of thesis front page and of final student evaluation form	Dec III	
For doctoral students in extended period:		
Proposal of members for final exam Committee	Mar IV	
Admission of doctoral student to final exam	May IV	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Admission of doctoral student to required further 6-month extension period	May IV	Approval of analytical report and of thesis structure description. Short doctoral student evaluation (max 10 lines e-mail).
Signature of thesis front page and of final student evaluation form	Jun IV	
For doctoral students in further extended period:		
Proposal of members for final exam Committee	Sep IV	
Admission of doctoral student to final exam	Nov IV	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Signature of thesis front page and of final student evaluation form	Dec IV	

8.1.5 Curriculum Coordinator and Director schedule

The School management foresees periodic activities, listed in the following table.

Event	Period	Activity
Renew of agreement with consortiated Universities	Jan	
Meeting with first year doctoral students	Jan	
Update on mobility fund availability	Jan	
Election of doctoral students representatives	Jan	
Proposal of Curricula and School activation for next cycle	Jan	CINECA forms to fill
Steering Board and School Board meeting	Feb	
Proposal of members for final exam Committee (doctoral students in extended period)	May	
Proposal of members for next admission exam Committees	Mag	
School Board meeting	Jun	
Signature of booklet, of thesis front page and of final student evaluation form (doctoral students in extended period)	Jun	
Final exam Committee (doctoral students in extended period)	Jul	CINECA forms to fill
Admission exam Committees	Jul	CINECA forms to fill
School Board meeting	Jul	
Activation of next PhD cycle call	Jul	CINECA forms to fill

Event	Period	Activity
Proposal of members for final exam Committee	Sep	
Foreign candidates evaluation (Cariparo grants call)	Sep	
Final exam Committee	Oct	CINECA forms to fill
Doctoral School summary	Oct	CINECA forms to fill
Admission exams	Oct	
Requests of Ministery grants	Nov	CINECA forms to fill
Steering Board and School Board meeting	Nov	
Signature of booklet, of thesis front page and of final student evaluation form	Dec	

8.2 Management of financial resources

All funds are managed by the Director, in accordance with the procedures established by the University; they are mainly dedicated to cover the mobility of doctoral students. The Director communicates to first year doctoral students what resources are available to each of them for covering their mobility expenses during the three years of the School.
The funds must also cover the mobility expenses of Director and Scientific Committee.

8.3 Mode of meetings

The Steering Committee shall be convened by the Director at least twice a year. For questions that require a quick resolution, the Committee may meet by electronic means. The annual progress report and program as for Art. 10 Paragraph 2 of the University PhD School Rules must be approved in a joint session with the Board of the School.
The Curriculum Boards shall meet at least three times a year, by electronic means if necessary, on the invitation of the Curriculum Coordinator. The meeting may also be requested by the Steering Committee or by one third of the members of each Board. Minutes of the meetings are prepared by the Curriculum Coordinator which sends them to the Director who shall forward them to the PhD University main office, with attached requests for justification.
The School Board shall be convened by the Director at least once in a year. Minutes of the meetings are prepared by Director which sends them to PhD University main office, with attached requests for justification.

8.4 Evaluation of the School

At the end of the third year, students fill in the anonymous questionnaire shown in Appendix 10.6, which is made known to the Steering Committee. The external evaluation of the School is done by the Scientific Committee in accordance with a form provided by the University.

9 School Resources

This section lists the main hardware and software resources available in the various Departments to which doctoral students may have access. This list is in continuous evolution, and is meant to convey an idea of the broad spectrum of resources available to the students.

9.1 Department of Industrial Engineering (University of Padova)

- equipments dedicated to testing of space instruments
- clean room of class 100
- dynamical analysis and structures test room
- 3 thermo-vacuum chambers for tests of space components
- laboratory dedicated to fluidoelasticity, servomanipulators, vibration mechanisms, tribology and diagnostics of machines, equipped with:
- dynamic tests equipments (fatigue, shakers)
- instrumentation for noise and vibration analyses
- small subsonic wind tunnel
- anemometers, Pitots manometers
- Laser
- Stroboscopes
- data logger for strain gages, temperature sensor
- vision system for dimensional measuring
- pneumatics, hydraulics, electrical actuators PLC
- microprocessors for control and simulator
- computing facilities:
- several PC and servers; connection with University computer centre and CINECA complex;
- softaware packages: ESATAN, I-DEAS, ESABASE, GUERAP, NASTRAN, MARC, for structural and thermal analyses and space data base

9.2 Department of Information Engineering (University of Padova)

- M3.5/M4.5 clean room (35 square meter) equipped with laminar bench (M3.5), optical bench and Zygo interferometer
- One cubic meter high vacuum chamber with electrical feedthrough for testing and calibrating flight instrumentation; it is interfaced with the clean room
- Normal incidence monochromator for characterizing optical elements and detectors in the 30-500 nm spectral region
- Grazing incidence monochromator for the 1-30 nm spectral region
- High vacuum system for reflectivity measurements in the EUV and soft X spectral region
- Vacuum deposition system
- High vacuum system for testing on photon counting detectors
- X-ray source (2-60 keV), Manson X-ray source (0.1-25 nm), hollow cathode source (20-200 nm), deuterium source, several spectral lamps
- MAMA and delay line detector for photon counting in the EUV
- Several CEMs, operating both in analog and photon counting regimes
- Intensified CCD camera, several CCD cameras from X-ray to near IR
- Calibrated photodiodes to operate in the 0.1-1100 nm
- Cary V spectrophotometer
- Solar simulator
- Pico ammeter
- Quadrupole for gas residual analysis
- Oscilloscopes
- Several different lasers: Nd, Ar+, excimer, Nd-YAG

9.3 Department of Physics and Astronomy (University of Padova)

- Telescopes in Asiago: 122 cm, 182cm 67/92 Schmidt.
- Several spectrographs of low and medium resolution, with CCD detectors. Imaging Camera with CCD detector.
- Access to 3.5m TNG in Canary Islands, to ESO Telescopes in Chile.
- Computing facilities
- Local network connected to the University computer center, CINECA and Asiago.
- Software packages: MIDAS, IRAF, VISTA, IDL, LSQR, JPL ephemeris, CLEAN, MATHLAB, CODE-V, ESABASE.

9.4 Department of Geosciences (University of Padova)

- software packages: Bernese 5.0, Spidernet(Leica), EuroNet (Euronik), Matlab con Map Module, COMSOL (elementi finiti) con modulo di meccanica strutturale, compilatori Fortran Lahey Fortran 95 e Borland Visual C++
- GPS antenna/receivers (Permanent GPS network of Veneto)
- PIXE equipments for aerosol analyses, APM_elecos for aerosol sampling (it worked in Antarctica);

9.5 Department of Mechanics and Aeronautics Engineering ("Sapienza" Università di Roma)

- optoelectronic system for gait analysis VICON 512
- two force platforms (6 degree of freedom) AMTI
- one mobile force platform AMTI
- robot for the arm rehabilitation IMT2
- automatic data acquisition system National Instruments

9.6 Mechanical and Industrial Engineering Department (Brescia)

- Post Rig/Vehicle motion simulator for multiaxial vibration test
- Electrodynamic shaker
- Reconfigurable acquisition system for high performance applications
- Mechatronics Lab
- Robotics Lab

9.7 Department of Mechanical and Structural Engineering (Trento)

- Coordinate Measuring Machine CMM
- Robot manipulator
- Termal Vacuum chamber TV
- fiber bragg sensor interrogator
- a system for image processing in Real Time - NI CVI
- Agilent multisensor conditioning system
- 4 channel oscilloscope 5 GSamples/s - Yokogawa

9.8 Department of Industrial Engineering (Perugia)

- Thermoelasticity measurement system Stress Photonics Delta Therm 1560, pirometre
- 2 lock-in EG&G amplifier and 2 filter set EG&G
- 2 Ometron Spate 9000 heads
- Agema 900 thermography
- Strani Gauge, installation kit, tester and Vischi signal conditioning system
- Thermocouples, thermoresistence, digital thermometers,
- Data acquisition system for thermocouples 8 channels (PC board)
- Power meter Newport, kit for fiber optic assembly RS, photodyodes, laser dyodes, optical fibers and connectors, laser He-Ne, optical table, fiber optic collimators, fiber couplers, etc.

- Optical fiber strain guges FBG and MicronOptics interrogation system
- Image acquisition and processing system (NI board, Dalsa camera, PC)
- Contact pressure measurement system by Novel
- LMS with Scadas III measurement and processing system for modal analysis
- Accelerometers, load cell, 3 PCB hammers, 3 proximity
- Test bench for little electric motors testing
- Hydraulic test rig for flow meter calibrations
- Test bench for hydrophone analisis of leakedge
- Electrodynamics test bench equipped with shaker Ling - LDS 1600 N
- Shaker B&K 4810
- test bench of gears by thermoelasticity
- test bench of specimen by thermoelasticity
- Spectrum analyzer ONO-SOKKI, oscilloscopes, multimeters, milliohmeter, signal generators Hameg
- Data acquisition cards National Instruments AT-MIO-16 DE 100 Ks/s, oscilloscope/analyzer of spectrum bichannel for PC type PICO

9.9 Department of Mechanics (Ancona)

- Scanning Laser Doppler Vibrometers (4 systems)
- Laser Doppler Vibrometers (3 single-point, 1 tangential, 1 rotational)
- Hemi-anechoic chamber
- Sound meters
- Acoustic intensity system
- Near-field Acoustic Holography
- Modal analysis software
- Instrumented impact hammers and electro-dynamic shakers
- Piezo accelerometers
- FFT spectral analyzers
- Digital oscilloscopes
- Multi-channel signal acquisition boards (PXI)
- Two-components laser Doppler anemometer
- 2D and 3D Particle Image Velocimetry
- Wind tunnels and constant head hydraulic test facility
- Hot-wire anemometers and flowmeter (rotameter, electromagnetic, turbin)
- Pressure sensors
- Pitot tubes
- 2D ESPI system
- General purpose instrumentation
- Strain gages system
- Ultrasound system
- Pressure matrices (16 X16 sensors)
- Strain gage and piezoelettric load cells
- 3 D Force platform and instrumented handle
- Non-contact surface geometry measurement system
- Triangulation optical sensors
- Precision translation stages (high-resolution positioners)
- 2 and 3 axis scanning Cartesian robot.

10 Appendixes

10.1 Syllabi of the courses activated by the PhD School STMS

10.2 “Passed exam” form

10.3 Personal training plan

10.4 Analytical report of the doctoral activities

10.5 Evaluation for the admission to the final exam

10.6 STMS PhD School evaluation form

Syllabi of the courses activated by the PhD School STMS

1. Interdisciplinary courses

Astronomical observations (Prof. C. Barbieri)
Stucture of the terrestrial atmosphere. Chromatic refraction, effects on astrometric measurements in the visible and in the radio bands. Effects on spectrophotometry. Dynamics of the atmosphere, structure of the image, scintillation, seeing, radiation propagation time.

Fundamentals of measurements for engineering (Prof. S. Debei)
Statistical data: probability distributions (Gaussian, equally likely, Weibull) (outline); functional analysis of a measurement chain (notes), development of time-varying data: frequency analysis, filtering, sampling, aliasing, leakage, function transfer (notes), application examples: a) statistical, b) frequency analysis, c) transfer function and bandwidth.

Fundamentals of space systems (Prof. A. Francesconi)
Space systems engineering, space systems elements, space mission phases. Orbit selection, special orbits for Earth missions (repeating groundtracks, sun-synchronous, highly elliptic). Flight segment, preliminary sizing of the electric power subsystem, Telecommunication subsystem, attitude control subsystem, thermal control subsystem

Fundamentals of Aerospace Instrumentation (Prof. E. Lorenzini)
Basic knowledge of measurement systems. Examples of dynamic instruments response: zero-order, first order, second order. Open loop and closed loop systems. Accelerometers examples. Examples of applications of accelerometers in aerospace.

Physics and effects of space environment (Prof. F. Marzari)
The course will focus on the space environment of the Solar System. The magnetic fields of the planets and the sun and their effects on charged particles will be analyzed with special attention to the Van Allen Belts. The dimension, origin and variability of the magnetosphere and its interaction with the solar wind are also studied.

How to prepare a research proposal (Prof. G. Naletto)
What is a research proposal. Evaluation of a research proposal. Examples of research proposals: PRIN Calls, Post Doc grants, University Projects, space mission proposal.

Space Science Instrumentation (Prof. G. Naletto)
Light as an electromagnetic wave, and its main properties. Light propagation and image formation. Lenses, mirrors, astronomical telescopes. Space instrumentation examples: MeteoSat and SPOT; the Wide Angle Camera for the Rosetta mission.

Radiation detectors (Prof. L. Poletto)
Fundamentals on radiation spectrum, wave equation, propagation of the light. Photoelectric effect. Metallic photodiodes and photocathodes. Detector classification: integration- or photon-counting-type. Basic concepts on imaging detectors: resolution, contrast, MTF, Nyquist frequency. Photomultipliers and channel electron multipliers. Microchannel plates. Photodiodes. CCD and CMOS-APS. X-ray detectors. Infrared detectors.

Measurement systems for diagnostics and control (Prof. G. Rossi)
Monitoring and diagnostic of machines and mechanical systems related to maintenance. Diagnostic by vibration measurements, acoustic measurements, acoustic emission, infrared thermography. Example and applications.

2. Syllabi of the courses dedicated to the MMIS Curriculum

Introduction to space robotics (Prof. F. Angrilli)
Introduction to new trends in robotics. Purposes of space robots: handling of structures (e.g. building elements during ISS assembly and maintenance), handling of tools and carrying out of specific and general tasks (assistance or replacing of man during EVA), moving of space instruments (automatic pointing of telescopes), planetary exploration (aerial, terrestrial, sub-surface), maintenance of satellites during their orbit (single o constellations), building of new types of telescopes and robotic explorers (formation flight, robot cooperation).

Biomechanical measurements (Prof. P. Cappa, "Sapienza" University of Rome)
Historical notes on biomechanical measurement procedures. Biomechanical measurement techniques (articular segments position measurements, force measurements): state of the art. Metrological quality of biomechanical measurements, experimental methods for biomechanical measurements, quality improvements.

Measurements of size and motion with vision systems (Prof. P. Castellini)
Introduction to basic concepts of vision systems. 2D: examples and evaluation of measurement uncertainty. 3D: major conceptual schemes of measurement systems. Examples of systems to single point, line and field. Discussion on current legislation relating to the uncertainty of measurement.

Dynamics and control of free-flying robotic systems for space applications (Ing. S. Cocuzza)
Mission scenarios. Sequence of operations and their criticalities. Kinematics and dynamics of a free-flying robotic system. Redundancy and optimization: review of real-time control methods for the minimization of the dynamic disturbance transferred to the spacecraft during manipulator manoeuvres. Robust reaction control methods and multi-objective optimization. Zero reaction workspace of 2D, 3D, and hyper-redundant robots. Capture of a non-cooperative tumbling target with unknown dynamic parameters. Dynamic coordination of multi-arm systems. Effect of joint flexibility and compensation methods. Control systems and strategies. Methods for the on-ground testing. Methods and systems for the measurement of base reactions and of position, attitude, and angular velocity of the robot base and target. Demonstration of the presented concepts with a 3D software simulator.

Temperature measurements in hostile environment (Prof. S. Debei)
Examples of hostile environment in relation to temperature measurements, contact and non-contact temperature measurements (notes); examples of temperature contact and non-contact measurements in hostile environments.

Characterization and measurement techniques for biological and engineered tissues (Prof. Z. del Prete)

PC-based measurement system development and management (Ing. M. Lancini)
Measurement system fundamentals and vocabulary. Digital acquisition and signal analysis in time and frequency domain. Measuring in uncontrolled environments and long duration measurements. Results processing principles. Databases and GIS for measurement results.

Airport acoustics (Prof. Moschioni, held at Milan Pol.)

Measurements with vision systems and LIDAR sensors (Ing. M. Pertile)
Introduction to probabilistic robotics: Bayes filter and examples; probabilistic model of a sensor (e.g. LIDAR); mapping an unknown environment with known position of the sensor; localization with a known map of the environment; introduction to Simultaneous Localization and Mapping.
Measurements with vision systems: displacement measurement of an object with a fixed camera and displacement measurement of the vision system with a fixed environment (ego-motion). Measurement with LIDAR sensors: mapping; localization in known environment. Methods for uncertainty expression, evaluation and propagation.

Non contact measurement of stress, strain and dynamical mechanical analysis (Prof. G. Rossi)
Thermal radiation, thermography, differential thermography. Thermoelastic measurement principle. Measurement of stress field by thermoelasticity (TSA). Heat transfer effects. Application on composite materials, modal analysis, fracture mechanics, rotating components. Digital Image correlation (DIC) for strain field measurement. Applications. Dynamic Mechanical analysis principle for material characterization. Main testing systems and machines. Applications and integrations with TSA and DIC.

Sensors and transducers for clinical and biomechanical measurements (Prof. Steindler, Prof. Del Prete, "Sapienza" Università di Roma)
Historical notes on measurement techniques in the field of biomechanics. State of the art techniques of measurement in biomechanical (position measurements of articular segments, force measurements). Metrological quality of the measurements made in the field of biomechanical experimental methods, experimental methodologies to improve the quality of measurements in biomechanical.

Structure vibration (Prof. Vanali, held at Milan Pol.)

3. Syllabi of the courses dedicated to the STASA Curriculum

Measuring systems for the thermal and attitude control for aerospace applications (Prof. C. Bettanini)
Overview of the main applications of thermal and attitude control for space systems. Emphasis to the choice and use of measuring instruments for the definition of active or passive control techniques, given the operational and environment requirements of either orbiting missions or planetary exploration.

Environment effects on the detectors (Prof. D. Bisello)
Radiations in space environment (electrons, protons, ions). The interaction of radiation with matter. Radiation effects on electronic components (ionization damage, displacement damage and single event effects). The "SPENVIS" ESA simulation software.

In orbit satellite tracking and orbit determination (Prof. A. Caporali)
Spatial and temporal reference systems. Orbit dynamics numerical integration of the equations of motion. Measurements of range, pseudorange, angles and Doppler. Systematic errors and calibration. Linearising the measurement equations. Model of the processes. Estimation of the orbital parameters. Prediction of the position of a spacecraft.

Dinamica Orbitale (Prof. S. Casotto)

Progettazione Ottica (Prof. V. Da Deppo)
Raytracing software basics. Merit function, optimization and aberration control. Optical performance analysis: spot diagrams, PSF and geometrical/diffraction encircled energy. Practical optical design examples: lenses and astronomical telescopes.

Orbit and attitude control (Prof. R. Da Forno)
One degree of freedom mechanical systems control; extension to the multi-degrees of freedom case. Attitude control for large rotations. Trajectory control for UAV (Unmanned Aerial Vehicle). Numerical solution presentation.

Mechanics of composite materials (Prof. U. Galvanetto)
Composite materials are finding an increasing use in the engineering fields where high specific properties (strength/weight, stiffness/weight) are required. Planes and spacecraft are typical structures in which the need of weight reduction makes composite materials very convenient.
The knowledge of a wide spectrum of different disciplines is required to understand and operate with composite materials: micro-mechanics, manufacturing processes, anisotropic elasticity, chemistry etc ... The lecture course is more concerned with the structural aspects of the use of composites and therefore it provides the preliminary elements for the structural design of structures made with heterogeneous materials and for the evaluation of their strength and stiffness.

Techniques for dynamic analysis in Hamiltonian systems and applications (Prof. M. Guzzo)
The aim of this course is to present recent results concerning the dynamics of quasi-integrable Hamiltonian Systems, which represent the natural background for the mathematical study of many gravitational problems. Starting from the crisis of classical integrability, established by the Poincarè theorem on non-existence of first integrals, we describe the dynamical picture emerging from the KAM and Nekhoroshev Theorems and the problem of Arnold diffusion. Special emphasis will be given to applications to specific examples, especially through the use of numerical methods.

Geology and exploration of terrestrial planets (Prof. M. Massironi, Prof. G. Cremonese)
The course aims to give the basic knowledge of the geology of the planetary bodies in the inner solar system and of their exploration. The course topics include: physical parameters of the terrestrial planets comparison; impact craters and cratering history through density, geology and exploration of Mercury, Venus, Moon and Mars, space missions and instruments for the exploration of the terrestrial planets.

Propulsione aerospaziale (Prof. D. Pavarin, Prof. M. Manente)
Description at sub-system level of Chemical propulsion system, Tsiolkovsky equation. Performance parameters, specific impulse, system specific impulse. Characteristic velocity. Nozz,e simplified equations, converging divergin nozzles, pressure profile within the nozzle, nozzle performances at different altitude. Solid rocket motors, general description, main components, equilibrium pressure, main operative parameters, erosive combustion. Liquid Rocket Motors, main components, pressurization systems. Electric propulsion, low thrust conditions, Tsiolkovsky equations in case of low thrust conditions, Eletcrothermal , Electrostatic and electromagnetic propulsion systems.

Optical coating and multilayer structures (Prof. M.-G. Pelizzo)
Fresnel's equations, polarization by reflection, interference, and multi-layered structure and propagation of radiation in multilayer. Coating optical single film: materials and optical constants, deposition and characterization techniques, efficiency and lifetime of the coating. Examples of applications to optical telescopes and probes. Interference anti-reflective coating, glass and high-pass filters and low-pass interference filters. Materials and construction of structures. Examples of applications in astronomy. Efficiency of reflection and transmission of the optics in the EUV and X regions The grazing incidence. Structures in multilayer nano-structured applications for EUV and X: principles of operation, construction and characterization. Examples of application to the solar coronagrafia. Guided tour of the laboratories LUXOR.

Thermo-mechanical design of instrument for space applications (Prof. M. Zaccariotto)
Structural design of instruments for space applications, definition and identification of main external and internal loads, resistance criteria for metallic, optical glasses and composite materials; study of the

expected thermal and mechanical disturbances during a space mission, methods of thermo-mechanical optimization for the reduction of disturbances effects.

Passed exam form

The undersigned Prof. .... states that the doctoral student ...., student code (matricola) .... has positively passed the exam of the .... course.

Type of exam:

[ ] project work (tesina)

[ ] colloquium

[ ] seminar held in foreign language (not Italian)

[ ] academic lecture

[ ] other (please, specify): ....

The course is:

[ ] activated by the STMS PhD School

[ ] activated by the doctoral School of ....

[ ] activated by the bachelor/master Course of ....

[ ] other (please, specify): ....

Having passed this exam, the student acquires .... credits (either ECTS or CFU).

Date: ....

Signature..

CISAS-UPD

UNIVERSITÀ DEGLI STUDI DI PADOVA
Scuola di Dottorato in Scienze, Tecnologie e Misure Spaziali

PERSONAL TRAINING PLAN OF DOCTORAL STUDENT XXX YYY

EDUCATIONAL ACTIVITIES ACTIVATED BY THE STMS PHD SCHOOL							
Course/Seminar (Period/Date)	Teacher	Duration (hours) of course / seminar	Attainable ECTS credits	Frequency (YES/NO)	Exam (YES/NO and type)*	Date of exam**	Attained ECTS credits
OTHER EDUCATIONAL ACTIVITIES							
Title of the activity (Date/Period)	Teacher	Duration (hours) of activity	Attainable ECTS credits	Frequency (YES/NO)	Exam (YES/NO and type)*	Date of exam**	Attained ECTS credits
Total of ECTS credits attainable in educational activities (>30):				Total of ECTS credits attained in educational activities: date DD MM YYYY			

* Write here the foreseen type of exam (project work, colloquium, foreign language seminar, academic lecture, other).
** Not to be filled in at the presentation of the plan. At the updates, it has to be written when (2-month approximate period) the student foresees to do / has done the exam.

CISAS-UPD

UNIVERSITÀ DEGLI STUDI DI PADOVA
Scuola di Dottorato in Scienze, Tecnologie e Misure Spaziali

Analytical report of the doctoral activities

RESEARCH TITLE (THESIS): ....

DOCTORAL STUDENT: ....
e-mail address: ....

CURRICULUM
[ ] Mechanical Measurements for Engineering and Space (MMIS)
[ ] Sciences and Technologies for Aeronautics and Satellite Applications (STASA)

TYPE OF GRANT
[ ] University grant
[ ] Ministry of Research (Fondi MIUR sostentamento giovani, ex legge 170) in the field of ....
[ ] Other funding source, free subject. Specify the funding source: ....
[ ] Other funding source, defined subject. Specify both the funding source and the research subject: ....
[ ] No grant

SUPERVISOR: .... **CO-SUPERVISOR**: ....

DEPARTMENT (INSTITUTE) OF REFERENCE: ....

EVENT:
[ ] Presentation of the proposed research program
[ ] Request of admission to the second year of the PhD School
[ ] Request of admission to the third year of the PhD School
[ ] Request of admission to the final exam
[ ] Request of extension period for the final exam

RESEARCH OBJECTIVES AND INTERNATIONAL FRAMEWORK
Description of the objectives of the research and of the international framework (one page maximum)

REPORT ON THE ACTIVITIES PROGRAM (description of what has been done and analysis of what has to be done)
First and second year doctoral students: description of the activities done during the last year (one page maximum). Third year doctoral students: description of the activities done during the whole three-year period (two pages maximum).
Work Breakdown Structure of the research/educational program done and/or foreseen: a) level 1 for the presentation of the research program; b) level 2 for admission to the second year; c) level 3 up for other admissions. Any Work Package (WP) has to be suitably described. Also the time distribution (man-hours, 1500 per year) has to be indicated per each WP and for the educational activities (750 hours total).
GANNT bar-chart of the activities program done and/or foreseen, in agreement with the WBS: a) for the presentation of the research activity a 3-month time scale at the first year, and 6-month time scale at the following two years is required; b) for the admission to the second and third year, a 3-month time scale is required.

NATIONAL AND INTERNATIONAL COLLABORATIONS
List of the collaborations done and/or foreseen

INDUSTRY COLLABORATIONS
List of the collaborations with industry done and/or foreseen

PERIODS SPENT ABROAD
List of the period spent outside of Italy related to the research activity. Specify location and duration.

FORESEEN AND ACTUAL RESEARCH PRODUCTS
[ ] new equipment
[ ] new know-how
[ ] publications
[ ] new process
[ ] new methods
[ ] spin-off(s)

PERSONAL TRAINING PLAN
Attach here the personal training plan. Describe in this section how it is planned to recover possible delays with respect to the foreseen plan.

SUPERVISOR APPROVAL
The supervisor, Prof. .... approves this analytical report of the activities program.
[NB: For the presentation of the proposed research program this line has not to be filled in, because the supervisor has not been officially assigned yet]

UNIVERSITÀ DEGLI STUDI DI PADOVA
Scuola di Dottorato in Scienze, Tecnologie e Misure Spaziali

School evaluation of the PhD student *Name Surname* for the admission to the final exam

Thesis Title: ……………………………

List of attended educational School activities and of passed exams:

…………………………………………………

List of attended Conferences, Schools, International meeting:

…………………………………………………

Periods spent outside Italy:

…………………………………………………

List of publications:

…………………………………………………

Research outputs (i.e. new equipment, processes, know-how, methodologies, spin-offs, …):

…………………………………………………

Other scientific/academic/industrial commitments during the PhD period:

…………………………………………………

Evaluation of the Thesis:

………………………………………………… *(to be filled in by the Supervisor)*

Evaluation of the PhD student attitude about possible future activities in an academic or non academic environment

………………………………………………… *(to be filled in by the Supervisor)*

Other comments:

………………………………………………… *(to be filled in by the Supervisor)*

The Supervisor: Prof. *Name Surname*

The School Curriculum coordinator: Prof. *Name Surname*

The School Director: Prof. *Name Surname*

Approved by the School Board on: .... *(type the date of the School Board admission meeting)*

CISAS-UPD	**UNIVERSITÀ DEGLI STUDI DI PADOVA** **Scuola di Dottorato in Scienze, Tecnologie e Misure Spaziali**

Evaluation of the School by students at the end of the third year

QUESTIONNAIRE

1. What was the relevance of the PhD STMS School imagined when registering for the course for your future career? (Enter a number in the scale of 0 to 10 where 0 means it is a doctorate as others, and 10 indicates extremely relevant)
2. The school has met your initial expectations ? (Give a number between 0 and 10 where 0 means “not at all”, and 10 means “completely”)
3. How would you rate the supervision and/or assistance of your supervisor ? (Give a number between 0 and 10 where 0 is “non-existent” and 10 being “excellent”)
4. How would you rate the relationship with doctoral students implemented by the Curriculum Coordinator ? (Give a number between 0 and 10 where 0 means “unacceptable” and 10 being “excellent”)
5. How would you rate the relationship with doctoral students implemented by the School Director ? (Give a number between 0 and 10 where 0 means “unacceptable” and 10 being “excellent”)
6. Having in mind the number of 750 hours in three years to devote to educational training program (number set by the Ministry of Education for a doctoral class), how do you assess the course structure adopted by the School (mandatory lectures, curriculum dedicated courses, seminars, etc.) ? (Give a number between 0 and 10 where 0 is “too rigid and unsustainable” and 10 being “excellent”)
7. How do you rate the lessons of School teachers, on average? (Give a number between 0 and 10 where 0 means “totally useless” and 10 being “excellent”)
8. How do you rate the degree of interdisciplinary educational activities offered by the School? (Give a number between 0 and 10 where 0 is “non-existent” and 10 being “high grade”)
9. How do you rate the significance of the course exams ? (Give a number between 0 and 10 where 0 means “irrelevant” and 10 means “very adequate”)
10. Have you had difficulty in disposing of tools, equipment and bibliography necessary for the development of the thesis? (Give a number between 0 and 10 where 0 means “too much” and 10 means “none”)
11. What is your level of satisfaction with the mobility funds made available by the research group you belong to? (Give a number between 0 and 10 where 0 means “completely dissatisfied” and 10 means “very satisfied”)
12. Write any comment you feel important to improve the School (continued on the back, max 1 page)