



**PhD Course in  
Space Sciences, Technologies and Measurements**

**Corso di Dottorato in  
“Scienze Tecnologie e Misure Spaziali (STMS)”**

**University of Padua - Italy**

**(<http://cisas.unipd.it/dottorato.php>)**

**PhD Course Specifications and Program for 2014  
(updated on 6 February 2014)**

**Foreword**

This Document describes the STMS PhD Course composition, activities, structure and resources foreseen in 2014.

This Document is yearly updated by the PhD Course Board. 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 PhD Course, namely to provide excellence in education and formation. Variations to what here written are possible under acceptance of the PhD Course Board, always staying within the limitations foreseen by the Academy and PhD Course Rules.

Doctoral students follow the indications given in the Document corresponding to the year of enrollment, unless differently stated by the STMS PhD Course Board.

Note: some didactical activities and some dates on the Course Organization are still undefined in this document, due to the very recent change of the PhD Course Rules by the Ministry. Some of the consequences of this change have been a redefinition of the Course Board and a different thesis evaluation process: the first impacted on our didactical activities, the latter is leaving undefined some deadlines at the end of the PhD period. We are presently working to reconfigure the PhD Course didactical offer, while we have to wait indications from the main Office to know the details of the new thesis evaluation procedure.

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# 1 STMS PhD Course Rationale

The main purpose of the Space Sciences, Technologies and Measurements (STMS) PhD Course (hereafter, the Course) 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 Course 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 STMS PhD Course derives from merging two previous PhD Courses, *Space Sciences and Technologies*, and *Mechanical Measurements for Engineering*, that has enlarged the capability of the Course 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 Involved institutions

The reference University Institution for the STMS PhD Course is the Center of Studies and Activities for Space (in Italian “Centro di Ateneo di Studi e Attività Spaziali”, hereafter CISAS) “Giuseppe Colombo”, for administration.

The Departments involved in the STMS PhD Course are:

*University of Padova:*

Civil and Environmental Engineering, Geosciences, Industrial Engineering, Information Engineering, Physics and Astronomy, Mathematics

*from other Italian Universities:*

Design and Planning in Complex Environments (IUAV, Venice), Industrial Engineering (University of Perugia), Industrial Engineering (University of Trento), Mechanical and Industrial Engineering (University of Brescia), Mechanics (Polytechnics of Milan)

For any information relative to the STMS PhD Course, the reference person are Prof. Giampiero Naletto (Coordinator) and Dr.ssa Federica Sannito (Secretary).

### 2.1 International Agreements

The STMS PhD Course 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 Course 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 Course 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 Course is (University codes):

10: Industrial Engineering

Other scientific areas of interest for the Course 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 Curricula have been instituted in the STMS Course, 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 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 STMS PhD Course Governing Bodies

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

- a) the Course Coordinator
- b) the PhD Course Board (“Collegio docenti”)
- ~~c) the Steering Committee (“Consiglio Direttivo”), if present~~

Their composition and capacities are specified by the University Regulations document (Art. 10, 11, 12, 13 and 14), and by the specific Course’s Regulations (in Italian, Regolamento dei Corsi di Dottorato).

The present composition of the governing bodies is the following:

*Coordinator:* Prof. Giampiero Naletto

*Deputy Coordinator:* Prof. XXX

*PhD Course Board:*

Barbieri Cesare Padova , Dip. Fisica e Astronomia	Expert
Bisello Dario Università di Padova , Dip. Fisica e Astronomia	Professor
Caporali Alessandro Università di Padova, Dip. Geoscienze	Professor
Casotto Stefano Università di Padova, Dip. Fisica e Astronomia	Researcher
Riccardo Claudi Padova, INAF OAPD	Researcher
Cremonese Gabriele Padova, INAF OAPD	Researcher
Da Deppo Vania Padova CNR-IFN	Researcher
Debei Stefano Padova, Dip. Ingegneria Industriale	Professor
De Cecco Mariolino Università di Trento, Dip. Ingegneria Meccanica e Strutturale	Professor
Franceschini Giordano Università di Perugia, Dip. Ingegneria Industriale	Professor
Francesconi Alessandro Padova, Dip. Ingegneria Industriale	Researcher
Galvanetto Ugo Università di Padova, Dip. Civile, Edile e Ambientale	Professor
Guzzo Massimiliano Università di Padova, Dip. Matematica	Professor
Lancini Matteo Università di Brescia, Dip. Ingegneria Meccanica e Industriale	Researcher
Lorenzini Enrico Università di Padova, Dip. Ingegneria Industriale	Professor
Marzari Francesco Università di Padova, Dip. Fisica e Astronomia	Researcher
Moschioni Giovanni Milano Politecnico, Dip. Meccanica	Professor

Naletto Giampiero Università di Padova, Dip. Ingegneria dell'Informazione	Professor
Pavarin Daniele Università di Padova, Dip. Ingegneria Industriale	Researcher
Pelizzo Maria-Guglielmina Padova, CNR-IFN	Researcher
Peron Fabio IUAV Venezia, Progettazione e pianificazione in ambienti complessi	Professor
Rossi Gianluca Università di Perugia, Dip. Ingegneria Industriale	Professor
Zaccariotto Mirco Università di Padova, Dip. Ingegneria Industriale	Researcher
Paola Zuppella Padova CNR-IFN	Researcher
VVV	PhD Student Representative*
WWW	PhD Student Representative*
XXX	PhD Student Representative*
YYY	PhD Student Representative*
ZZZ	PhD Student Representative*

\*advisory function, until 31 December 2014. The number of doctoral student representatives is given by excess rounding the 15% of the total number of the Board components. Their participation is limited (by the Rules) to questions related to didactical and organization aspects.

#### Steering Committee:

1	Barbieri Cesare	Dean Deputy Coordinator	cesare.barbieri@unipd.it
2	Caporali Alessandro	CISAS Representative STASA Deputy Coordinator	alessandro.caporali@unipd.it
3	Debei Stefano	MMIS Course 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	Coordinator STASA Course Coordinator	giampiero.naletto@unipd.it
9	Rossi Gianluca	Universities in the MMIS consortium Representative	gianluca@unipg.it
10*	XXX	PhD Student Representative	
11*	YYY	PhD Student Representative	

\* advisory function, until 31 December 2014

## **6 Main research topics of the Course**

### **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<sup>1</sup>) 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 Course, as well the relative exam procedures. All the lectures, unless otherwise indicated, are held at CISAS.

Changes to the program provided by the Course may be requested by the student, and must be approved by the Course Coordinator.

##### 7.1.1.1 Interdisciplinary courses **TO BE REVISED**

The interdisciplinary courses proposed by the Course are nine modules of 10 hours of lectures each. Given the variety of university education of the Course students and the cultural diversity of the two Course 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 Course 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 Course 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)

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<sup>1</sup> 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.

Interdisciplinary course for *not-engineering graduated* students

- 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, and 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 Course Coordinator.

Lessons on the same subjects can also be attended in other universities, with permission of the Course 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 Course, 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 Course Secretary).

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

The number of ECTS credits typically achieved with mandatory interdisciplinary modules is  $5 \times 2.4 = 12$ , 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 Course 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 Course Board in special cases such as prolonged staying abroad.

### **7.1.1.3 Other interdisciplinary activities**

Doctoral students may participate, after having informed the Course Board, to the ESA Rexus/Bexus Programs, as this activity is extremely educational. In this case, the doctoral students acquire 6 ECTS credits, which can be used as an alternative or complement to other interdisciplinary activity.

Doctoral students, if willing, can attend the English Language 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 Course an excellent knowledge the English language. The courses will be partially funded (half the cost) by the Course. Only the course frequency will be considered in the student credit account.

Foreign students can attend the "Italian for foreigners" 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 Course. This course, however, is not considered valid 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 frequency to this course is useful in terms of credits to be considered 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:

- Presentations done by the first year doctoral students admitted to the Course of their proposed three-year PhD research program (1/6 ECTS credit for attendance; 1/3 ECTS credit for presentation)
- Presentations done by the doctoral students of the activities done during the year (for first and second year students), or of the activities 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 Course 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 courses activated by the PhD Course must have priority with respect to other Curriculum specific training activities.

Courses whose syllabus is similar to those listed above can be attended as an alternative to those activated by the Course also in other universities, for example in case of off-site doctoral students, with permission of the Course Coordinator. In exceptional cases, with the permission of the Course Coordinator, a doctoral student may be exempted from lecture attendance; however, the obligation of study and exam will remain. The Course Coordinator will determine the number of credits to be awarded to the student in such cases. Changes with respect to the program of Course provided Curriculum dedicated educational activities may be requested by the student, and have to be approved by the Course Coordinator.

#### **7.1.2.1 Courses dedicated to the MMIS Curriculum**

The following courses dedicated to the MMIS Curriculum can be activated by the Course 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:

##### ~~Dynamics and control of free flying robotic systems for space applications (Prof. S. Cocuzza)~~

- Temperature measurements in hostile environment (Prof. S. Debei)
- 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 dynamical mechanical analysis (Prof. G. Rossi, held at the University of Perugia)

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 Course Coordinator.

The following undergraduate courses, if chosen by a doctoral student of MMIS Curriculum, do not require formal 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 Course 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)
- 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](http://sirad.pd.infn.it/scuola_legnaro)) is automatically recognized as specific training activity; it is strongly suggested to attend this School, that can also be used as alternative the "Environment effects on the detectors" course. 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 Course Coordinator.

The following undergraduate courses, if chosen by a doctoral student of STASA Curriculum, do not require formal 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)

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 exams, 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 Course 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 Course 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 students have to comply with the standards commonly used for software development, and for this purpose appropriate documentation can be made available. These doctoral students will have to demonstrate the understanding of these standards and their application in the developed software codes. This can be done by means of a “software review”, which is an optional exam where 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 2 ECTS credits.

#### **7.1.2.6 Other Curriculum dedicated educational activities**

Doctoral students can dedicate up to 40 hours per year on educational support or on integration to university courses (after the third year, there is no longer the 40 hour limitation). These activities must be approved by Course Board, following the directions of the Academic Bodies. In Appendix 10.3 there is a template for the request to the Board. In addition to this request of authorization, the doctoral student has to send to the Course Board also the approval of this activity by the Supervisor. 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 3.2 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 Course Coordinator and to the Course Secretary of proper documentation of participation in the School or 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 activated by the Course. 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 Course 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 could be acquired. The template for the personal training plan can be found in Appendix 10.4 (it can be released in word format by the Secretary).

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 Course Coordinator, until the end of the second year. Any changes to the training plan as foreseen by the Course have to be described in the personal training plan, and must be approved by the Course 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 Course, 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 Course. 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 PhD Course 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 PhD Course 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 PhD Course 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.>>>>

<<<<Lo/a studente/ssa di dottorato *Nome Cognome* del *NNN* ciclo, curriculum *MMIS/STASA* chiede al Collegio del Corso l'autorizzazione a trascorrere il periodo da ... a ... presso *Istituto/Università* a *Città (Stato)* per svolgere delle attività di ricerca sotto la supervisione di *Nome Cognome*. L'oggetto della ricerca durante questo periodo sarà .... Il supervisore, Prof. *Nome Cognome*, approva questa richiesta.>>>>

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 final title of the thesis must be determined at the end of the second year; later 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 PhD Course Board. Since the topics covered in this Doctoral Course 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 PhD Course Board: this request must be made at the end of the first year of the PhD, when presenting the documentation for admission to the second year.

The thesis, regardless of the language in which it is written, must however contain a section summarizing the work done either in Italian or in English (or in another foreign language indicated by the PhD Course Board).

### **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 also in bullet form indicating what are 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 PhD Course Board:

- a complete index (content) of the thesis.

For admission to the third year, the student must submit to the PhD Course 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 PhD Course 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.

In all cases, 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.

Note that the writing of the thesis typically requires about 10% of the total commitment for research (i.e. more than 3 months): it is required that the doctoral 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.s 30-32 of the University Regulations on Doctoral Thesis are here reported (in Italian) at Appendix 10.5.

## 8 STMS PhD Course Management

### 8.1 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 PhD Course Board: shortly after admission to the Course 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 10.6.

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 PhD Course 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 10.7.

#### 8.1.1 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.

##### 8.1.1.1 Example of Work-Breakdown Structure (WBS)

Level	Activity description (WP title)	hours	I year					II year			III year		
<b>1</b>	<b>0 0</b>	<b>1060</b>	<b>150</b>	<b>250</b>	<b>250</b>	<b>250</b>	<b>160</b>						
	1 0	250	150	100									
	1 1	100	50	50									
	1 2	150	100	50									
	2 0	550		150	200	200							
	2 1	150		100	50								
	2 2	100		50	50								
	2 3	100			100								
	2 4	200				200							
	3 0	260			50	50	160						
	3 1	100			50	50							
	3 2	160					160						
<b>2</b>	<b>0 0</b>	<b>1070</b>				<b>250</b>	<b>280</b>	<b>300</b>	<b>145</b>	<b>95</b>			
	1 0	400				190	140	70					
	2 0	670				60	140	230	145	95			
	2 1	390				60	140	130	45	15			
	2 2	280						100	100	80			

<b>3</b>	<b>0</b>	<b>0</b>		<b>1070</b>								<b>100</b>	<b>350</b>	<b>350</b>	<b>200</b>	<b>70</b>
	1	0		600								100	200	200	100	
	2	0		470									150	150	100	70
<b>4</b>	<b>0</b>	<b>0</b>	<b>Writing Thesis and reports</b>	<b>550</b>					<b>20</b>	<b>35</b>	<b>50</b>	<b>70</b>	<b>45</b>	<b>80</b>	<b>100</b>	<b>150</b>

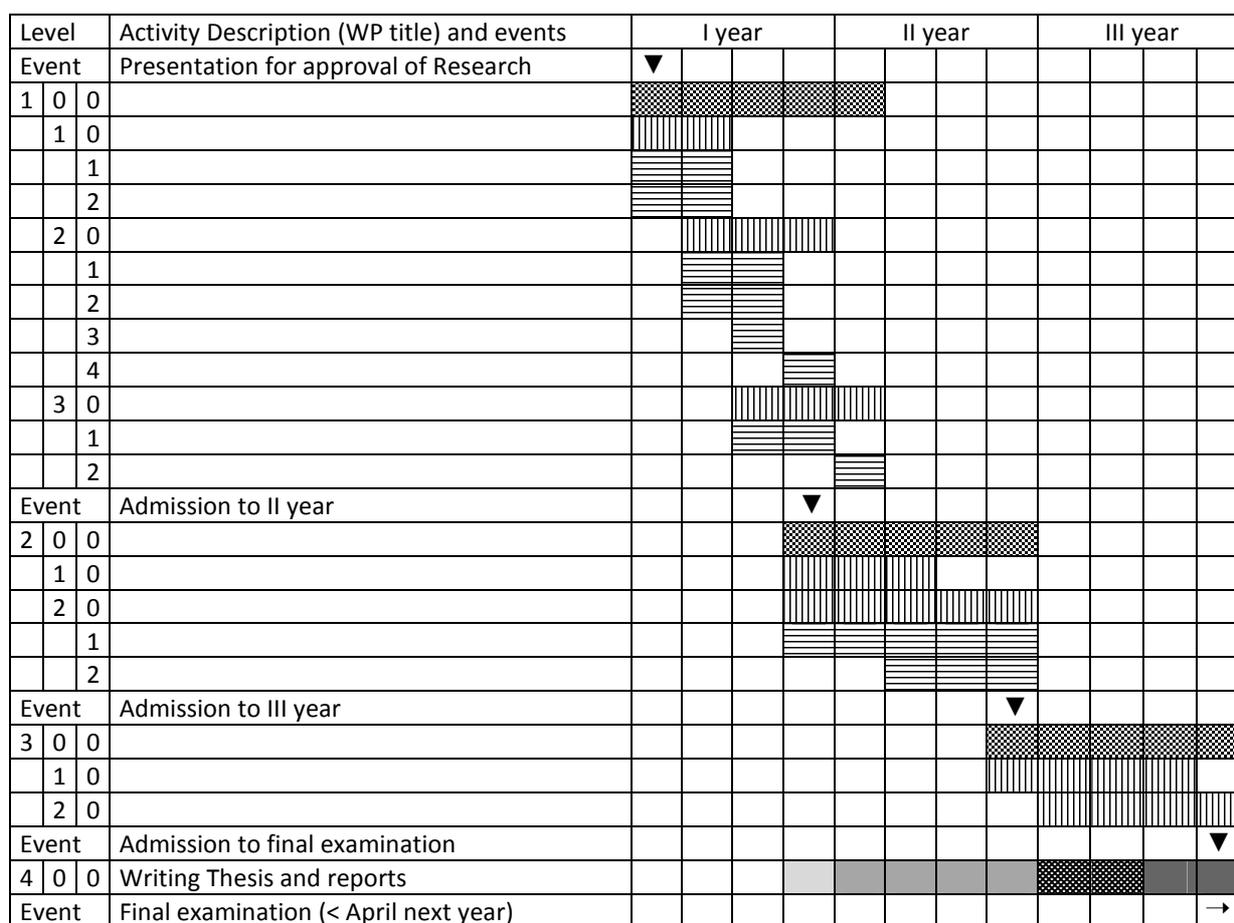
*Note: X00 is a level 1 WP, XY0 is level 2 WP, XYW is level 3 WP. Students beginning the first year should show an analysis at least to level 1; for admission to second year, an analysis to at least level 3 is requested. Note: it is convenient to not exceed with the first level WP (i.e., no more than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

### 8.1.1.2 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	

### 8.1.1.3 Example of research program GANNT Bar Chart



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.

## 8.2 PhD Course program management

The program of the PhD Course 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	Coordinator
Communication about mobility funds availability	Jan	First year	Coordinator
Doctoral student representative election	Jan	All	Coordinator
Presentation first year research programs	Feb	All	Course Board and Supervisors
Course Board meeting	Feb	Representatives	Course Board and Supervisors
Final exam (ordinary session)	Spring	Students admitted to the final exam	Coordinator
Training program update	May	Second and third year students	Coordinator
Course Board meeting	Jun	Representatives	Course Board and Supervisors
Lectures	Jun-Jul	Involved students	Involved teachers
Lectures	Sept	Involved students	Involved teachers
English course ( <a href="http://claweb.cla.unipd.it/cla/DIY.html">http://claweb.cla.unipd.it/cla/DIY.html</a> )	Sept	Involved students	CLA teachers
Training program update	Sept	First year students	Coordinator
Final exam (extra session)	Autumn	Students admitted to the final exam (with extension)	Coordinator
Admission exam	October		Coordinator and exam board
Training program update	Nov	All	Coordinator
Admissions to 2nd and 3rd year, admissions to final exams	Nov	All	Course Board and Supervisors
Course Board meeting	Nov	Representatives	Course Board and Supervisors

### 8.2.1 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 STMS PhD Course by the Coordinator
Risk assessment form	Jan I	Submission of the risk assessment form
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 Course 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 Course Board meeting Presentation of the research activity done during the first year

<b>Event</b>	<b>Period</b>	<b>Description and comments</b>
Doctoral student representative election	Jan II	
First year student presentation	Feb II	Participation is advised
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 Course 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	
First year student presentation	Feb III	Participation is advised
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	???	
Admission to final exam or to the requested extension period	???	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 Course Board meeting Presentation (in English or other agreed foreign language) of the research activity done during the whole PhD period
Delivery of the thesis to the evaluators	???	The thesis has to be essentially complete
Delivery of the thesis to the reviewers (for the Doctor Europaeus "mention")	???	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 Coordinator and Supervisor
Delivery of evaluation Course form	???	
Delivery of the thesis	???	
Final exam	???	Thesis discussion with an external Board
<b><i>For doctoral students requiring extension:</i></b>		
Possible request of Doctor Europaeus "mention" or of further extension of thesis delivery	???	
Admission to final exam or to the further extension period	???	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 Course 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 evaluators	???	The thesis has to be essentially complete

Event	Period	Description and comments
Delivery of the thesis to the reviewers (for the Doctor Europaeus "mention")	???	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 Coordinator and Supervisor
Delivery of the thesis	???	
Final exam	???	Thesis discussion with an external Board
<b><i>For doctoral students requiring further extension:</i></b>		
Possible request of Doctor Europaeus "mention"	???	
Admission to final exam or to the further extension period	???	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 Course 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")	???	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 Coordinator and Supervisor
Delivery of the thesis	???	
Final exam	???	Thesis discussion with an external Board

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. Participation to official Course events are certified by the Course Coordinator by signing the student booklet.

If a doctoral student cannot attend an official event, he/she has to send in advance a justification to the Secretary and the Coordinator for approval. In case of absence due to force majeure, the student is required to notify the Coordinator as soon as possible. In particular, an absence to the event where the presentation for admission to the following year of the doctorate has to be held can be justified only in case of illness or prolonged stay abroad. In this case, the student supervisor must make a presentation of the activities on behalf of the student. The absence to the event where the presentation for admission to the final exam has to be held will be considered case by case.

### 8.2.2 Documentation needed for formal approvals

Doctoral students have to provide the following documentation in electronic format to the Course Secretary.

Approval	Required Documentation
Admission	- Risk assessment form
Approval of personal training plan and of proposed research	- Analytical report, including personal training plan - Presentation of the proposed research program

<b>Approval</b>	<b>Required Documentation</b>
Admission to second year	<ul style="list-style-type: none"> <li>- 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</li> <li>- Complete index of the thesis</li> <li>- Declaration of updating the CINECA personal site</li> <li>- Request to write the thesis in English (or other agreed foreign language)</li> <li>- Presentation of the work done in the first year</li> </ul>
Admission to third year	<ul style="list-style-type: none"> <li>- 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</li> <li>- Description of thesis structure</li> <li>- Declaration of updating the CINECA personal site</li> <li>- Presentation in English of the work done in the second year</li> </ul>
Request of extension	<ul style="list-style-type: none"> <li>- 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</li> <li>- Description of thesis structure</li> <li>- Declaration of updating the CINECA personal site</li> <li>- Presentation in English of the work done in the third year (or of extension period, if any)</li> </ul>
Admission to final exam	<ul style="list-style-type: none"> <li>- 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</li> <li>- Draft of the thesis</li> <li>- Declaration of updating the CINECA personal site</li> <li>- Presentation in English of the work done during the PhD</li> </ul>

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

### 8.2.3 Supervisor schedule and list of the documentation

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

<b>Activities</b>	<b>Period</b>	<b>Required documentation</b>
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).
Admission of doctoral student to final exam	???	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Admission of doctoral student to required 6-month extension period	???	Approval of analytical report and of thesis structure description. Short doctoral student evaluation (max 10 lines e-mail).

Activities	Period	Required documentation
Indication of two reviewers for thesis evaluation	???	
Proposal of members for final exam Committee	???	
Signature of thesis front page and of final student evaluation form	???	
<b><i>For doctoral students in extended period:</i></b>		
Admission of doctoral student to final exam	???	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Indication of two reviewers for thesis evaluation	???	
Proposal of members for final exam Committee	???	
Admission of doctoral student to final exam	???	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Admission of doctoral student to required further 6-month extension period	???	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	???	
<b><i>For doctoral students in further extended period:</i></b>		
Admission of doctoral student to final exam	???	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Indication of two reviewers for thesis evaluation	???	
Proposal of members for final exam Committee	???	
Admission of doctoral student to final exam	???	Approval of analytical report and of thesis draft. Final doctoral student evaluation.
Signature of thesis front page and of final student evaluation form	???	

#### 8.2.4 Coordinator schedule

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

Event	Period	Activity
Meeting with first year doctoral students	Jan	
Update on mobility fund availability	Jan	
Election of doctoral students representatives	Jan	
Proposal of Curricula and Course activation for next cycle	Jan	CINECA forms to fill
Course Board meeting	Feb	
Proposal of evaluators for thesis approval	???	
Proposal of members for final exam Committee (doctoral students in extended period)	???	
Proposal of members for next admission exam Committees	???	
Course 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)	???	CINECA forms to fill
Admission exam Committees	???	CINECA forms to fill

Event	Period	Activity
Course Board meeting	Jul	
Activation of next PhD cycle call	???	CINECA forms to fill
Proposal of members for final exam Committee	???	
Foreign candidates evaluation (Cariparo grants call)	???	
Final exam Committee	???	CINECA forms to fill
Doctoral Course summary	???	CINECA forms to fill
Admission exams	???	
Requests of Ministry grants	???	CINECA forms to fill
Course Board meeting	Nov	
Signature of booklet, of thesis front page and of final student evaluation form	Dec	

### 8.3 Management of financial resources

All funds are managed by the Coordinator, in accordance with the procedures established by the University; they are mainly dedicated to cover the mobility of doctoral students. The Coordinator 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 Course.

The funds must also cover the mobility expenses of Coordinator.

### 8.4 Mode of meetings

The Course Board shall meet under invitation of the Course Coordinator, also by electronic means. Minutes of the meetings have to be sent to the PhD University main office, with attached the provided members requests for justification.

### 8.5 Miscellanea

#### 8.5.1 Risk assessment

All doctoral students have to fill at the beginning of their PhD activities a risk assessment form. This form can be found in Appendix 10.8. The form has to be filled in and sent to the Course Secretary as soon as the PhD activities start.

#### 8.5.2 External working activities

Doctoral students can make temporary external work activities if they are compatible with the foreseen full time PhD study and research commitments. These activities have to be approved by the Course Board. In Appendix 10.9 the template for asking this permission to the Course Board can be found.

#### 8.5.3 Evaluation of the Course

At the end of the third year, students fill in the anonymous questionnaire shown in Appendix 10.10, which is made known to the Course Board.

#### 8.5.4 Additional information

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

- PhD Courses 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)

## 9 PhD Course 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)

- equipment 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 fluideoelasticity, servo-manipulators, vibration mechanisms, tribology and diagnostics of machines, equipped with:
- dynamic tests equipment (fatigue, shakers)
- instrumentation for noise and vibration analyses
- small subsonic wind tunnel
- anemometers, Pitot 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 center and CINECA complex;
- software 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 equipment for aerosol analyses, APM\_elecoc for aerosol sampling (it worked in Antarctica);

### **9.5 Mechanical and Industrial Engineering Department (Brescia)**

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

### **9.6 Department of Mechanical and Structural Engineering (Trento)**

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

### **9.7 Department of Industrial Engineering (Perugia)**

- Thermoelasticity measurement system Stress Photonics Delta Therm 1560, pyrometer
- 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, thermo-resistance, digital thermometers,
- Data acquisition system for thermocouples 8 channels (PC board)
- Power meter Newport, kit for fiber optic assembly RS, photodiodes, laser diodes, optical fibers and connectors, laser He-Ne, optical table, fiber optic collimators, fiber couplers, etc.
- Optical fiber strain gauges 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 analysis of leakage
- 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, milli-ohmeter, signal generators Hameg
- Data acquisition cards National Instruments AT-MIO-16 DE 100 Ks/s, oscilloscope/analyzer of spectrum bi-channel for PC type PICO

## **10 Appendixes**

- 10.1 Syllabi of the courses activated by the STMS PhD Course**
- 10.2 Passed exam form**
- 10.3 Template of request of authorization for making educational support activity**
- 10.4 Personal training plan**
- 10.5 Extract from the University Regulations on Doctoral Thesis**
- 10.6 Analytical report of the doctoral activities**
- 10.7 Evaluation form for the admission to the final exam**
- 10.8 Risk Assessment form**
- 10.9 Template of request of authorization for temporary external job**
- 10.10 STMS PhD Course evaluation form**

# Syllabi of the courses activated by the STMS PhD Course

## 1. Interdisciplinary courses

### **Astronomical observations (Prof. C. Barbieri)**

Structure 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**

### **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.

### **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.

### 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.

#### **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. Nozzle simplified equations,

converging diverging 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, Electrothermal, 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 coronagraphia. 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 Course  
 activated by the doctoral Course/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.....

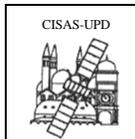


### **Template of request of authorization for making educational support activity**

Doctoral student *Name Surname* of *Number* cycle Curriculum *MMIS/STASA* asks to the PhD Course Board the authorization to participate to the selection Call for making educational support paid activity for the course *Name of the Course* held by Prof. *Name Surname* for the Graduation course in *Name of the Graduation Course*. The foreseen number of hours is *NNN*.

Lo/a studente/ssa di dottorato *Nome Cognome* del *NNN* ciclo, curriculum *MMIS/STASA* chiede al Collegio del Corso l'autorizzazione a partecipare al bando di selezione per svolgere attività didattica di supporto retribuita per il corso di *Titolo del corso* il cui titolare è il Prof. *Nome Cognome* per il Corso di Laurea / Laurea Magistrale in *Nome del Corso di Laura*. Il numero di ore di didattica previsto è *NNN*.

NB In addition to this request of authorization, the doctoral student has to send to the PhD Course Board also the approval of this activity by his/her Supervisor.



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

**PERSONAL TRAINING PLAN OF DOCTORAL STUDENT XXX YYY**

<b>EDUCATIONAL ACTIVITIES ACTIVATED BY THE STMS PHD COURSE</b>							
<b>Course/Seminar (Period/Date)</b>	<b>Teacher</b>	<b>Duration (hours) of course / seminar</b>	<b>Attainable ECTS credits</b>	<b>Frequency (YES/NO)</b>	<b>Exam (YES/NO and type)*</b>	<b>Date of exam**</b>	<b>Attained ECTS credits</b>
<b>OTHER EDUCATIONAL ACTIVITIES</b>							
<b>Title of the activity (Date/Period)</b>	<b>Teacher</b>	<b>Duration (hours) of activity</b>	<b>Attainable ECTS credits</b>	<b>Frequency (YES/NO)</b>	<b>Exam (YES/NO and type)*</b>	<b>Date of exam**</b>	<b>Attained ECTS credits</b>
<b>Total of ECTS credits attainable in educational activities (&gt;30):</b>				<b>Total of ECTS credits attained in educational activities:</b> 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.

## Extract from the University Regulations on Doctoral Thesis

### **TITOLO IV** **Conseguimento del Titolo**

#### **Art.30 - Valutazione della tesi e ammissione all'esame finale**

1. La tesi è valutata da due docenti di elevata qualificazione anche appartenenti a istituzioni estere, esterni ai soggetti che hanno concorso al rilascio del titolo di dottorato, di seguito denominati valutatori.
2. Entro la fine dell'ultimo anno di corso il Collegio docenti dovrà formulare un giudizio sull'attività di ricerca svolta dal dottorando e ammettere il dottorando alla valutazione della tesi da parte dei valutatori.
3. Il dottorando dovrà rendere disponibili ai valutatori:
  - a) la tesi;
  - b) il giudizio del collegio;
  - c) una relazione del dottorando stesso sulle attività svolte durante il dottorato e sulle eventuali pubblicazioni
4. Al fine di ottemperare a quanto previsto dall'art. 8 del DM 45/2013, il competente Servizio di Ateneo coordina una procedura atta a raccogliere i corrispondenti giudizi dei due valutatori esterni e attivare la successiva valutazione di una commissione di esame finale salvaguardando la possibilità del dottorando di poter riformulare la tesi di dottorato in caso di rinvio richiesto dai valutatori.
5. 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. Le proroghe possono essere richieste esclusivamente per periodi di sei o dodici mesi.
6. L'istanza di proroga deve essere inoltrata al Rettore entro le date che saranno rese note ai dottorandi via web.
7. 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. Sarà compito del dipartimento di afferenza definire l'eventuale inclusione in progetti di ricerca o aree tematiche di ricerca del dottorando in proroga che necessiti ulteriormente dell'utilizzo e della frequentazione del Dipartimento e delle sue strutture
8. L'esame finale consiste nella discussione della tesi di dottorato dinanzi alla Commissione di cui all'art. 31.
9. L'eventuale rinvio 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.

### **Art. 31 - Commissioni**

1. La nomina della Commissione giudicatrice è disposta con decreto del Rettore su proposta del Collegio dei docenti.
2. Il Collegio dei docenti, ove ne ravvisi la necessità, potrà segnalare più Commissioni in considerazione dei diversi percorsi formativi e di ricerca dei candidati. Le Commissioni di norma non potranno comunque essere più di una per curriculum attivato per il ciclo che si conclude.
3. Le dimissioni dei componenti delle Commissioni devono essere motivate.
4. Le Commissioni giudicatrici sono tenute a concludere le valutazioni entro novanta giorni dalla data del decreto rettorale di nomina. Decorso i termini suddetti, la Commissione che non abbia concluso i suoi lavori decade ed il Rettore nomina una nuova Commissione, con esclusione dei componenti decaduti.
5. La Commissione giudicatrice di esame finale sarà composta da un minimo di tre a un massimo di cinque membri effettivi e altrettanti supplenti, scelti tra professori, ricercatori universitari o esperti nelle discipline afferenti alle aree scientifiche cui si riferisce il Corso e appartenenti a Strutture di ricerca pubbliche e private, esclusi i supervisori dei dottorandi e i due valutatori della tesi.
6. La commissione, con voto unanime, ha facoltà di attribuire la lode in presenza di risultati di particolare rilievo scientifico

### **Art. 32 - Esame finale**

1. La domanda di ammissione all'esame finale dovrà pervenire al Rettore. 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.
2. La domanda di ammissione all'esame finale dovrà essere corredata:
  - a) della ricevuta dell'avvenuto deposito della tesi in formato digitale nel repository di Ateneo, anche ai fini di adempiere all'obbligo di deposito della tesi presso le biblioteche nazionali di Roma e Firenze;
  - b) un esemplare cartaceo della tesi per il deposito presso l'archivio dell'Ateneo
  - c) copia del giudizio analitico scritto sulla tesi dei valutatori con ammissione all'esame finale.
3. I dottorandi dovranno inoltre inviare, non appena sarà stata loro resa nota la composizione della commissione esaminatrice, una copia della tesi corredata dal giudizio dei valutatori a ciascuno dei componenti della Commissione.
4. Le tesi dovranno essere firmate dal Coordinatore del corso e dal Supervisore.
5. La data e il luogo d'esame verranno pubblicati nel sito Web di Ateneo.
6. 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 del Corso e dell'eventuale curriculum frequentato.
7. Al termine della discussione la tesi, con motivato giudizio scritto collegiale, è approvata o respinta.



## 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 Course
- Request of admission to the third year of the PhD Course
- 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]



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

**Thesis Title:** .....

**List of attended educational Course 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 Work:**

..... *(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 Course Course Coordinator: Prof. *Name Surname*

The Course Coordinator: Prof. *Name Surname*

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

**DICHIARO**

Ai sensi e per gli effetti delle disposizioni contenute nel D. Lgs. 81/08, che il sig./ra:

**Cognome** ..... **Nome** .....

**Nato a** ..... **il** ..... **tel.** .....

**in qualità di:** docente/ricercatore/professore  - tecnico/amministrativo  - dottorando  - specializzando  -  
assegnista  - laureando\*  - borsista  - tirocinante  ospite  - altro .....

**afferre alla struttura: codice** ..... **denominazione** .....  
(Dip./ Centro /Servizio ecc.)

**Data inizio attività:** ...../...../..... **Data di prevista cessazione:** ...../...../.....

**\* in particolare per gli studenti in tesi -**  
Laureando del Corso di Studi in: .....  
Relatore: .....

**INDIVIDUAZIONE DEI LUOGHI E/O DELLE AREE SEDE DI LAVORO**

(Per l'identificazione fare riferimento ai codici GEOTEC contenuti nelle planimetrie ufficiali di Ateneo)

Edificio (denominazione): ..... Edificio (Codice): ..... Piano: ..... Locale: .....

Locale o Laboratorio (Denominazione): .....

Struttura: (denominazione): ..... (codice): .....  
(Se diversa da quella di afferenza - Dip./ Centro /Servizio ecc.)

Responsabile del laboratorio: .....

**GLI SPAZI COMPREDONO (contrassegnare con X):**

Ufficio/studio – Biblioteca e/o archivio - Laboratorio meccanico / officina / falegnameria - Laboratorio Chimico -  
Laboratorio biologico - Laboratorio informatico - laboratorio con presenza di apparecchiature radiogene o sostanze  
radioattive - Campi, boschi, terreni – Ambulatorio - Sala Operatoria – Degenza - altro .....

**TIPOLOGIA DI RISCHIO (contrassegnare con X):**

Movimentazione manuale dei carichi - Videoterminale (> 20 ore/settimana) – Rumore – Vibrazioni – Campi  
elettromagnetici - Radiazioni ottiche artificiali - Agenti chimici - Agenti cancerogeni e mutageni\*\*\* (dati da specificare  
nella tabella allegata)  – Agenti biologici gruppo 1 e 2  - Agenti biologici gruppo 3 e 4 \*\* (dati da specificare nella  
tabella allegata) - MOGM  - Rischio Elettrico - Rischi attrezzature – Radiazioni ionizzanti - Altro .....

**\*\*Dati Agenti biologici utilizzati (gruppo 3 e 4)**

Agente Biologico	Attività Svolta (in breve)	Gruppo (3 o 4)

**\*\*\*Dati Sostanze cancerogene o mutagene utilizzate (R45;R46;R49, H340, H341, H350, H351)**

Sostanza o Miscela	N°CAS	Stato Fisico	Concentrazione

Data \_\_\_\_\_ Firma Responsabile/Referente \_\_\_\_\_

Timbro Dipartimento \_\_\_\_\_ Firma del Direttore \_\_\_\_\_



### Template of request of authorization for temporary external job

Doctoral student *Name Surname* of *Number* cycle Curriculum *MMIS/STASA* asks to the PhD Course Board the authorization to carry out a temporary job external di the PhD Course. The company interested in this activity is *XXX* that would initiate a contract *YYY* (specify the contract type).

I also declare that:

- my supervisor, Prof. *ZZZ*, approves this temporary job;
- the PhD remains my main full time activity, and that this temporary job will be done out of the timeframe foreseen for the PhD, without any consequence on the regular execution of the PhD activities;
- the payment agreed for this temporary job *respects/does not respect* the limitation set in the admission Call for having access to the PhD grants.

Il/la sottoscritto/a *Nome Cognome*, studente di dottorato del *NNN* ciclo, curriculum *MMIS/STASA* chiede al Collegio del Corso l'autorizzazione a svolgere una attività lavorativa temporanea esterna al Corso di Dottorato. L'azienda interessata a questa attività è *XXX* che attiverrebbe un contratto *YYY* (*specificare la tipologia del contratto*).

Dichiaro inoltre che:

- il mio supervisore Prof. *ZZZ* approva questa attività lavorativa temporanea;
- il dottorato rimane l'attività primaria a tempo pieno, e questa attività lavorativa temporanea sarà svolta nelle ore esterne alla schedula oraria del dottorato senza alcuna ripercussione sul regolare svolgimento delle attività del dottorato;
- il compenso pattuito per questa attività lavorativa temporanea *rispetta/non rispetta* i limiti imposti nel bando di ammissione per la fruizione della borsa di studio.

In addition to this request of authorization, the doctoral student has to send to the PhD Course Board also the approval of this activity by the Supervisor.



## Evaluation of the STMS PHD Course by students at the end of the third year

### QUESTIONNAIRE

1. What was the relevance of the PhD STMS Course 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 Course 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 Course 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 Course Coordinator? (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 Course (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 Course 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 Course? (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 Course (continued on the back, max 1 page)

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