Regulations for the Master Course in

SPACE AND ASTRONAUTICAL ENGINEERING

Class LM 20 – Aerospace and space engineering

Academic Year 2012/ 2013

Specific educational goals

The Degree in Aerospace Engineering & Astronautics aims to provide students with advanced professional scientific education with specific engineering skills that will enable them to cope with complex problems associated with analysis, development, simulation and optimisation. The course also aims to provide students with a suitable level of training on the fundamental elements of interplanetary missions, astronautical vehicles, re-entry capsules and manned space missions, with particular attention paid to the systems and scientific aspects.

The student's training is mainly aimed at the development of the most advanced survey and design instruments and innovation in the aerospace industry, focusing on improving efficiency and reducing weight. Some classic areas of investigation, such as satellites, useful loads, launch bases and vehicles, telemetering and telemetry systems, re-entry and landing sites, are reprocessed according to the presence of a human crew giving particular emphasis to the techniques and systems to support human life in space. Within this context, requirements in the presence of a human crew include reliability, safety, compatibility of the engineering project of the mission with the astronaut's physiological needs, bearing in mind their cognition and reaction skills and the limits of human performance in space environments also in conditions of psychological stress, and knowledge of international rules governing aerospace activities.

These skills and capabilities are achieved by enhancing the solid body of knowledge already acquired during the degree course, which is extended in terms of methodology and application throughout the two years of the Master course. The academic course foresees a first year study plan which focuses on consolidating knowledge in the various characterising aerospace engineering sectors (Gasdynamics, Aerospace Structures, Aerospace Flight Mechanics, Rocket Propulsion and aerospace systems) further to basic information in areas not included in the 3-year degree course, i.e. telecommunications, automation and electronics. In Year ll, there are various different study plans which focus on the launch structure and propulsion systems, aerospace platforms, earth observation and planning of aerospace and interplanetary missions.

Admission requisites and recognised credits

In order to be admitted to the Master Degree course, all candidates must have completed studies for a total of 72 ECTS credits in the following scientific-disciplinary sectors:
ING-IND/03, ING-IND/04, ING-IND/05, ING-IND/06, ING-IND/07, ING-INF/01, ING-INF/02, ING-INF/03, ING-INF/04, ING-INF/05, ICAR/08, INF/01, MAT /02, MAT/03, MAT/05, MAT/07, FIS/01, FIS/02, FIS/05, CHIM/07, of which at least 27 ECTS credits in scientific disciplinary sectors MAT/05, MAT/07, FIS/01, and 18 ECTS in scientific disciplinary sectors ING-IND/03, ING-IND/04, ING-IND/05, ING-IND/06, ING-IND/07, ING-INF/01, ING-INF/04.

Proficienty tests

The proficiency level of all candidates for the Master Degree course will be assessed by an admission test.
Exemption from the admission test is granted to students who, with "n" as the number of years taken to complete the 3-year Bachelor's degree and "M" as the weighted average based on credits for all the exams taken in the Bachelor degree, meet the following requirement

$$M \geq 21 + (n-4) \quad \text{with } n \geq 4$$

Students who do not meet this condition must sit and pass the written admission test, which will focus on general knowledge in the basic and characteristic subjects. The admission test will be held each academic year at a time which will be indicated on the Aerospace Engineering Academic Council www.ingaero.uniroma1.it website; students who have not yet completed their 3-year Degree Course can also sit the admission test.

Transfer and certification of study periods abroad

Courses taken at foreign or European Universities with which the Department of Aerospace Engineering has signed agreements, projects and/or contracts are recognised as prescribed by such agreements.
Upon receiving approval from the Degree Course Academic Council, students can spend a period of abroad as part of the LLP Erasmus Project.
In accordance with University Academic Regulations relating to studies, examinations and academic degrees earned abroad, the Degree Course Academic Council will examine the programme and assign the credits which correspond to the relative scientific disciplines.
If a student comes from another University, from another Sapienza Degree Course or other Academic Course, the Academic Council may recognise the credits acquired which do not exceed the Scientific Disciplinary Sectors - SDS indicated on the course programmes and up to a maximum of 12 University Credits in the SDS not foreseen in the course programme.
If the subject is no longer a student, the Academic Council may approve reinstatement according to the current regulations in force, recognising all or only part of the credits earned.
The transfer, ECTS recognition and reintegration procedures can be viewed in the Student Information section of the Aerospace Engineering Academic Council website (www.ingaero.uniroma1.it).

Attendance

Attendance is not compulsory.

Course details

The academic course foresees a first year study plan, identical for all curricula and divided into 7 modules for a total of 60 ECTS credits, which focuses on consolidating knowledge in the various characterising aerospace engineering sectors (Gasdynamics, Aerospace Structures, Aerospace Flight Mechanics, Rocket Propulsion and aerospace systems) further to basic information in areas not included in the 3-year degree course, i.e. electronics and automation or telecommunications.
In Year ll, there are 4 different study plans (Launchers, Satellites, Missions and Earth Observation) divided into two curricula and chosen groups, from which the students selects 4 modules for a total of 24 ECTS credits.
The percentage of the total hourly commitment that students may dedicate to personal studies or other individual academic activities is at least 68%.
The Master Course in Aerospace Engineering and Aeronautics is part of a French-Italian Network for the acquisition of the double-title at selected Universities and Grandes Ecoles in Paris, Grenoble, Toulouse, Nantes and Nice.

The agreement between La Sapienza and French Institutes, defines the operational details and the list of Level 1 titles (or: Level 2, Maitrise, and the Ecole title) that can be acquired at each Institute participating in the agreement.

Final exam

The final exam consists in preparing an experimental, project or design thesis on subjects relating to the teachings of the Master Course, to be developed under the guidance of an Academic Council Mentor, in collaboration with public and private entities, manufacturing and service companies or research centres operating in the area of interest.
During the preparation of the thesis, students must first analyse the technical literature available on the relative topic. The student must then autonomously, or according to the thesis topic, propose solutions to problems proposed with a modularisation that allows the answer to be analysed by the system according to the variations in the system characterisation variables. In the case of experimental thesis, students are required to draw up an experimental schedule that allows the desired results to be achieved. In the case of project thesis, students shall determine the characteristics of a space mission, a space vehicle, a satellite or a re-entry capsule (or part of the same), using calculation codes, highlighting the advantages obtained compared to the current solutions.
23 ECTS credits are awarded to the final test

Placements

Students can complete placements for which they will earn 23 credits, instead of taking the final exam. On approving the placement, an academic tutor, chosen from among the Academic Council lecturers, and a company tutor will be appointed to follow up the placement activities**.** The academic tutor will monitor and verify all results.

Educational methods and proficiency tests

Lectures, tutorials, workshops, group work, and any other activities lecturers deem appropriate, will be provided for each individual subject.
Proficiency tests for each subject normally consist of a written and/or oral exam (E), with procedures defined by the Lecturer and communicated together with the course programme.

Part-time

Freshmen and students who are also involved in other activities, can apply for Part-time attendance and plan to earn less UC each year than a full-time student.
The rules and procedures applicable to part-time attendance are provided in the University Regulations. Please consult the general University regulations for further details on the rights and duties of part-time students (http://www.uniroma1.it/didattica/regolamenti/part-time).

Free-choice subjects

As for the 12 credits earned on free-choice subjects, students can choose from the subjects foreseen for the Master Course which are not included in their study plan, from the Master Course in Aeronautical Engineering or subjects or similar sectors inherent to other Master Courses.
The Academic Council will check that the selected courses are inherent to the study plan before endorsing such requests.

Study plan

Students are required to submit their study plan (Infostud Educational Programme function) including no less than 96 UC, **at the beginning of Year One** of the course [roughly during the

period from September 1 to September 30 and, more specifically, in the periods which will be constantly updated on the Aerospace Engineering Academic Council website (News area)].

Regulations regarding change of year and relative prerequisites

Students must have gained at least 27 credits in Year I in order to move on to Year II.
Credits must be acquired by January 31st of the solar year following the registration academic year.
Students who repeat Year 1 can request to take a maximum of 2 Year II exams, as illustrated in the relative Student Information section on the Academic Council website.

Programmes and exam papers

The academic programmes and exam papers can be viewed on the Aerospace Engineering Academic Council website (www.ingaero.uniroma1.it).

Tutoring services

The study course also foresees tutoring provided by the Department of Aerospace Engineering. The lecturers Paolo Gaudenzi, Luciano Iess, Marcello Onofri and Giovanni Palmerini provide tutoring to students.

Quality assessments

The Degree Course Academic Council, in collaboration with the Department of Aerospace Engineering will conduct surveys on the opinions of students attending the relative academic courses. The survey system is part of a quality programme which the self-assessment group, lecturers, students and academic course operators all work towards. The survey results and analysis conducted by the self-assessment group are used to improve all teaching and academic activities.

Career and employment opportunities for graduates

Career opportunities for aerospace and astronautic engineers are related to the in-depth skills and expertise acquired in an extremely wide range of productive and management activities.
Some examples of possible career opportunities include:
- public and private research centres as research and development operators and/or coordinators
- industrial sectors as project designers or managers;
- national and international aerospace agencies dedicated to the planning, realising and management of space missions

Those holding master degrees in Aerospace Engineering and Astronautics are also qualified to work in all related sectors that reap advantages from the high scientific and technological content of this type of education.

2012/13 STUDY PLAN

There are four study plans to choose from, divided into two different branches which have the same study plan in Year I. Lessons will be held in the two facilities at S. Pietro in Vincoli (SPV) and via Salaria 851, Urbe Airport (URB). First year classes will be held at San Pietro in Vincoli.

BRANCH A - LAUNCH VEHICLES SATELLITE AND SPACE MISSION

1. Launch Vehicle Speciality Plan (LAN)

The study plan varies from the defining of routes into orbit and relative guiding, to navigation and control problems, the designing of rocket systems, using both solid and liquid propellant, to structural problems of launch elements. Given the involvement of the Sapienza University in the VEGA programme, students are able to gain knowledge on the system, from the vehicle conception and design and engineering phases through to the actual launch campaign, with in-depth studies of the various subsystems that compose an aerospace transport vehicle according to the specialty branch selected.
For this speciality branch, Basic Automation is recommended for Year I.

All second year classes will be held at San Pietro in Vincoli

2. Satellite Speciality Plan (SAT)

The course is focused on the general design & engineering of a satellite with particular attention paid to the energy and thermal balance, structural and technological problems, electric, electronic and telecommunication subsystems, further to the satellite control and set-up systems.
Students have at their disposal a vast choice of laboratories and benefit from the experience accumulated over the years by the Rome University in the design & engineering, construction, launching and operations in orbit of small platforms.
For the Satellite speciality branch, Basic Automation is recommended for Year I.
Second year classes will be held at the Urbe Airport facility (except for the Telecommunication and Remote Sensing course) during the first semester and at the S. Pietro in Vincoli facility during the second semester.

3. Mission Speciality Plan (MIS)

This specialty plan aims to prepare engineers in the analysis of missions orbiting the earth and exploring the solar system. This includes orbital design & engineering and control, with particular reference to the state-of-the-art route analysis techniques, paying special attention to the fields of current interest such as robotic missions and satellite constellation and formation missions.
For this speciality branch, Basic Automation is recommended for Year I.

Second year classes will be held at the Urbe Airport facility during the first semester and at the S. Pietro in Vincoli facility during the second semester.

BRANCH B – EARTH OBSERVATION

4. Earth Observation Speciality Plan (OST)

This study plan focuses on the use of satellites for telecommunication applications, acquisition and processing images of the earth using optic and radar systems.

The students analyse and experiment complete development cycles for these types of missions, from the observation payload selection and project to the processing of realised images and their utilisation using information extraction techniques.
For this speciality branch, Telecommunications, remote sensing and satellite telecommunication systems are recommended for Year I.
Classes will be held on alternative days at the Urbe Airport facility during the first semester and at the S. Pietro in Vincoli facility during the first and second semester.

STUDY PLAN

FIRST YEAR (a.a. 2012/13)

STUDY PROGRAM IDENTICAL FOR BOTH BRANCHES

Subject	Sector	UC	Activity type	Sem.	Site
Gasdynamics	ING-IND/06	9	B	1	SPV
Space Flight Mechanics	ING-IND/03	9	B	1	SPV
9 UC at choice from the following type C subjects					
Automatic Control	ING-INF/04	9	C	1	SPV
Identification and Filtering of Dynamics Systems [1]	ING-INF/04	9	C	2	SPV[3]
Telecommunication, Remote Sensing and Satellite Telecommunication Systems Mod. 1: **Telecommunication** Mod. 2: **Remote Sensing** Mod. 3: **Satellite Telecommunication Systems**	 ING-INF/03 ING-INF/03 ING-INF/03	9 (3) (3) (3)	C	1	SPV
6 UC at choice from the following type C subjects					
Electronics	ING-INF/01	6	C	2	SPV
Satellite Electronics [2]	ING-INF/01	6	C	2	SPV
Space Structures and Systems	ING-IND/04	9	B	2	SPV
Space Missions and Systems	ING-IND/05	9	B	2	SPV
Rocket Propulsion	ING-IND/07	9	B	2	SPV

Notes:
(1) Compulsory course for students who have completed the INSA Branch of the 3-year study course. None of the other students can include this course in their Year 1 study plan.
(2) Compulsory course for students a) who have completed the INSA Branch of the 3-year study course, b) who registered during the 2009/10 academic year for the 3-year study course (Didactic Regulations academic year 2009/2010 and have completed the SAIN branch and taken the **Electronics** exam. None of the other students can include this course in their Year 1 study plan.
(3) The classes are held at the Department of IT and Systems Engineering, via Ariosto 25.

SECOND YEAR (a.a. 2013/14)

BRANCH A - Launch Vehicles, Satellites and Space Mission

Launch Vehicles Speciality Plan

18 UC at choice from the following type B subjects

Subject	Sector	UC	Sem.	Site
Hypersonics	ING-IND/06	6	1	SPV
Flight Mechanics of Launcher	ING-IND/03	6	1	SPV
Solid Propulsion Modeling		6	2	SPV
Mod. 1	ING-IND/07	(3)		SPV
Mod. 2	ING-IND/06	(3)		SPV
Liquid Propellant Engines	ING-IND/07	6	1	SPV
Turbopump Systems for Liquid Rocket Engines	ING-IND/07	6	2	SPV
Navigation Systems	ING-IND/05	6	1	SPV
Smart Structures and Thermoelasticity	ING-IND/04	6	2	SPV

6 UC at choice from the following type C subjects

Subject	Sector	CFU	Sem.	Site
Spacecraft Control	ING-INF/04	6	1	SPV
Aerospace Materials	ING-IND/22	6	2	SPV

Satellites Speciality Plan

18 UC at choice from the following type B subjects

Subject	Sector	UC	Sem.	Site
Space Environment and Instrumentation.	ING-IND/05	6	2	SPV
Space Vehicle Thermal Control Systems	ING-IND/05	6	1	URB
Space Vehicle Design	ING-IND/05	6	1	URB
Space Propulsion	ING-IND/07	6	2	SPV
Multibody Space Structures	ING-IND/04	6	2	SPV
Technologies of Aerospace Materials	ING-IND/04	6	1	URB

6 UC at choice from the following type C subjects

Subject	Sector	UC	Sem.	Site
Space Systems Electronics	ING-INF/01	6	1	URB
Satellite Electrical Systems	ING-IND/33	6	2	SPV
Telecommunication and Remote Sensing		6	1	SPV
Mod. 1: **Telecommunication Principles**	ING-INF/03	(3)		
Mod. 2: **Remote Sensing Principles**	ING-INF/03	(3)		

Mission Speciality Plan

18 UC at choice from the following type B subjects

Subject	Sector	UC	Sem.	Site
Space Environment and Instrumentation	ING-IND/05	6	2	SPV
Space Propulsion	ING-IND/07	6	2	SPV
Space Guidance Systems	ING-IND/05	6	1	URB
Robotic Space Systems	ING-IND/05	6	1	URB
Interplanetary Trajectories	ING-IND/03	6	1	URB

6 UC at choice from the following type C subjects

Subject	Sector	UC	SEM	Site
Biological Effects of Space Environment and Protection Systems	MED/08	6	1	URB
Space Systems Electronics	ING-INF/01	6	1	URB
Artificial Intelligence	ING-INF/05	6	2	SPV[(3)]

BRANCH B – EARTH OBSERVATION

Earth Observation Speciality Plan

12 UC at choice from the following type B subjects

Subject	Sector	UC	Sem.	Site
Space Vehicle Thermal Control Systems	ING-IND/05	6	1	URB

Laboratory of Images Acquisition and Processing	ING IND/05	6	2	URB
Space Vehicle Design	ING-IND/05	6	1	URB
Observation and Surveillance Systems	ING-IND/05	6	2	URB
Space Structure Technologies	ING-IND/04	6	2	URB

12 UC at choice from the following type C subjects

Subject	Sector	UC	Sem.	Site
Satellite Electrical Systems	ING-IND/33	6	2	SPV
Space Systems Electronics	ING-INF/01	6	1	URB
Spacecraft Control	ING-INF/04	6	1	SPV
Radar Image Processing	ING-INF/03	6	1	SPV
Satellite Nav. & Radioloc.	ING-INF/03	6	2	SPV
Telecommunications Networks	ING-INF/03	6	1	SPV
Microwave Remote Sensing	ING-INF/02	6	2	SPV

OTHER COMMON ACTIVITIES

	Exam type	UC	Activity type
Exams chosen by the student	E	12	D
Other academic activity	V	1	AAF
Final exam		23	E

Key
Academic activity types: basic A, characteristic B, analogous and additional C, free choice by students D, final test E, other academic activities (art 10, paragraph 1, sub-paragraph d) placements E.
Marking: E exam, V eligibility verification

The following courses are offered in English (entirely when attended by students of other nationalities or in part when attended by Italian students only): Space Environ & Instrum., Aerospace Materials, Liquid Propellent Engines, Smart Structures and Thermoelasticity, Multibody Space Structures.

Prerequisites

It is not possible to sit exams on	if students have not passed the exams on
Spacecraft Control	**Automatic Control**
Radar Image Processing	**Telecommunication, Remote Sensing and Satellite Telecommunication Systems**
Hypersonics	**Gasdynamics**
Solid Propulsion Modeling	**Gasdynamics, Rocket Propulsion**
Liquid Propellant Engines	**Gasdynamics, Rocket Propulsion**
Satellite Nav. & Radioloc.	**Telecommunication, Remote Sensing and Satellite Telecommunication Systems**
Telecommunications Networks	**Telecommunication, Remote Sensing and Satellite Telecommunication Systems**
Turbopump Systems for Liquid Rocket Engines	**Gasdynamics, Rocket Propulsion**
Multibody Space Structures	**Space Structures**

LIST OF YEAR II COURSES GROUPED BY BRANCH

as per the Infosud STUDY PLAN format

- **LAN Launch Vehicle Speciality Plan**
- **SAT Satellite Speciality Plan**
- **MIS Mission Speciality Plan**
- **OST Earth Observation Speciality Plan**

BRANCH A - LAUNCH VEHICLES SATELLITE AND SPACE MISSION

18 UC at choice from the following

Subject	Sector	**Percorso**	UC
Space Environ & Instrum.	ING-IND/05	SAT/MIS	6
Space Vehicle Thermal Control Systems	ING-IND/05	SAT/OST	6
Hypersonics	ING-IND/06	LAN	6
Flight Mechanics of Launcher	ING-IND/03	LAN	6
Solid Propulsion Modeling	ING-IND/07	LAN	6
Space Vehicle Design	ING-IND/05	SAT/OST	6
Liquid Propellent Engines	ING-IND/07	LAN	6
Space Propulsion	ING-IND/07	SAT/MIS	6
Turbopump Systems for Liquid Rocket Engines	ING-IND/07	LAN	6
Space Guidance Systems	ING-IND/05	MIS	6
Navigation Systems	ING-IND/05	LAN	6
Robotic Space Systems	ING-IND/05	MIS	6
Multibody Space Structures	ING-IND/04	SAT	6
Technologies of Aerospace Materials	ING-IND/04	SAT	6
Smart Structures and Thermoelasticity	ING-IND/04	LAN	6
Interplanetary Trajectories	ING-IND/03	MIS	6

18 UC at choice from the following

Subject	Sector	**Percorso**	UC
Spacecraft Control	ING-INF/04	LAN/OST	6
Biological Effects of Space Environment and Protection Systems	MED/08	MIS	6
Space Systems Electronics	ING-INF/01	OST/SAT/MIS	6
Satellite Electrical Systems	ING-IND/33	SAT	6
Artificial Intelligence	ING-INF/05	MIS	6
Aerospace Materials	ING-IND/22	LAN	6
Telecommunication and Remote Sensing	ING-INF/03	SAT	6

BRANCH B – EARTH OBSERVATION

12 UC at choice from the following type B subjects

Subject	Sector	**Percorso**	UC
Space Vehicle Thermal Control Systems	ING-IND/05	OST/SAT	6
Laboratory of Images Acquisition and Processing	ING-IND/05	OST	6
Space Vehicle Design	ING-IND/05	OST/SAT	6
Observation and Surveillance Systems	ING-IND/05	OST	6
Space Structure Technologies	ING-IND/04	OST	6

12 UC at choice from the following type C subjects

Subject	Sector	**Percorso**	UC
Spacecraft Control	ING-INF/04	OST/LAN	6
Radar Image Processing	ING-INF/03	OST	6
Space Systems Electronics	ING-INF/01	OST/SAT/MIS	6
Satellite Electrical Systems	ING-IND/33	OST/SAT	6
Satellite Nav. & Radioloc.	ING-INF/03	OST	6
Telecommunications Networks	ING-INF/03	OST	6
Microwave Remote Sensing	ING-INF/02	OST	6