DIDACTIC REGULATIONS FOR THE DEGREE COURSE AEROSPACE ENGINEERING

CLASS LM-20

School: Polytechnic and Basic Sciences School

Department: Industrial Engineering

Regulations in force from the academic year 2024 -2025

ACRONYMS

CCD	Didactic Coordination Commission
CdS	Degree Course
CPDS	Joint Teachers-Students Committee
OFA	Additional Educational Obligations
SUA-CdS	Annual Single Course Schedule
RDA	University Didactic Regulations
SSD	Disciplinary Scientific Sector

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Art. 1
Object

1. These Didactic Regulations govern the organisational aspects of the CdS in Aerospace Engineering (class LM-20). The CdS in Aerospace Engineering (Ingegneria Aerospaziale, in Italian) is hinged into the Department of Industrial Engineering. The teaching language is Italian.
2. The Course is governed by the Didactic Coordination Commission (CCD), pursuant to Art. 4 of the RDA.
3. The Didactic Regulations are issued in compliance with the relevant legislation in force, the Statute of the University of Naples Federico II and the RDA.
4. The CdS in Aerospace Engineering has an educational pathway leading to the award of a Double Degree in Aerospace Engineering, issued by the University of Naples Federico II, and "Master en Ingeniería Aeronáutica", issued by the Escuela Tecnica Superior de Engineeria of the University of Seville (Spain).
   The criteria for the access to the double Degree Program, the period of teaching activities abroad and the Table of Correspondence of Training Activities are annexed to these Didactic Regulations.

Art. 2
Treaning objectives

The Aerospace Engineering is one of the most advanced sectors of Industrial Engineering due to the particularly stringent requirements in terms of: 1) weight reduction; 2) high performance; 3) operation in critical environments and situations; 4) security and reliability.
As a consequence, the studies are organized pursuing the following specific educational objectives:
1) provide the right balance between basic elements and specialized subjects
2) build an adequate training to deal with both classic problems of aerospace engineering and more stringent and modern ones in terms of technological content and continuous innovation
3) allow to follow the mobility and variability of the job market and ready for continuing education
4) build a mindset suitable for the management of codified procedures and standards and for the imagination of technological innovation, specific and continuous need of the aerospace sector
5) build a training capable of managing an interdisciplinary approach, suitable both for the management of complex systems and for interacting with collateral skills and with users of aerospace systems
6) provide the ability to use the main tools for calculating and measuring engineering parameters, with a specific focus on aerospace engineering.

In particular, master's degree graduates will have to:
- have an in-depth knowledge of the theoretical-scientific aspects of the basic sciences and be able to use this knowledge to understand and describe complex problems that require an interdisciplinary approach;
- have an in-depth knowledge of the theoretical-scientific aspects of engineering, specifically related to aerospace and astronautical engineering issues, in which they are able to identify, formulate and solve complex problems and/or problems that require an interdisciplinary approach;
- be able to conceive, design, manage and ensure the functionality of engineering systems and processes, with a preference for those in which aerospace disciplines and technologies play an important role

- be able to develop a critical sense towards new technologies, identify their development directions and promote technology transfer in harmony with existing solutions, with particular regard to engineering sectors involving aerospace and astronautics engineering and/or related areas in the various fields of industrial and information engineering.

The training course includes teaching activities in the characterizing fields of aerospace engineering and related ones, and courses in which the different teaching activities are grouped by degree of affinity. The presence of thematic areas allows a reasoned choice by the student within the educational offer, even if it is not formally restrictive. The definition of the thematic paths is referred to the Study Course regulations, where students are expected to be directed by means of automatically approved study plans, in which there are teaching activities concerning culturally similar subjects in fields such as Aeronautics and Space, allowing all achieve the same training objectives.

Within each of these areas, the course aims to provide students with insights into notions, principles, general methodologies and advanced modelling techniques largely in the first year, while the second year is oriented towards applications and experiences of industrial design, research and development. The degree course, in particular, offers students the opportunity to carry out internships to complete the educational offer. The internships takes place in Italian and international research, development and industrial production centres, also as part consolidated international student exchange programmes, and represent a characterizing element of the study program, since they can also be an integral part of the master's degree thesis .

Master’s Degree Graduates in Aerospace Engineering must be able to use the English language fluently and therefore an adequate number of credits is expected to be spent for the acquisition of these linguistic skills in the course if they are not possessed at the time of access to the course.

For the aforementioned needs of breadth and flexibility, it was decided to group related courses into thematic areas.

The SSD sectors of the first thematic area (A1) are intended to allow the consolidation of the basic and methodological knowledge and to acquire other skills in related areas of industrial engineering. In particular, the inclusion of the SSD MAT/02 sector offers the possibility of consolidating methodological knowledge on mathematical methods in engineering for physical-mathematical modelling. The ING-IND/13 Sector offers the possibility of expanding the cultural and professional aspects relevant to the study of mechanical systems.

The SSD sectors ING-IND/08, ING-IND/10, ING-IND/15, ING-IND/16 offer the possibility of acquiring further knowledge in culturally related areas of industrial engineering, particularly in emerging topics and in those contexts in which aerospace disciplines and technologies play an important role.

In the second area (A2), the SECS-S/02 sector allows to consolidate methodologies useful for the study of the reliability of complex systems such as aerospace ones. Group A2 also includes SSD Sector ING-IND/31 of the electrical engineering area and SSD ING-INF01, ING-INF/02, ING-INF/03, ING-INF/04, ING-INF/05 of information engineering, to provide the student with the opportunity to acquire knowledge in disciplinary fields that allow the acquisition of knowledge and insights on electrical, electromagnetic and electronic systems, sensors or devices, digital techniques or telecommunications systems that today play a role fundamental in aerospace and astronautical engineering. Finally, the ING-IND/35 sector was also included due to the usefulness of topics related to economic-management engineering for entering the world of work

A1
MAT/05 - Mathematical analysis
ING-IND/13 - Mechanics applied to machines
ING- IND08 Machines

ING-IND10 Industrial Technical Physics
ING-IND-15 Design and Methods of Industrial Engineering
ING-IND/16 - Processing technologies and systems

A2
SECS-S/02 - Statistics for experimental and technological research
ING-IND/35 - Economic-management engineering
ING-IND-32-Converters, Electrical Machines and Drives
ING-INF01 Electronics
ING-INF-02 Electromagnetic fields
ING-INF-03 Telecommunications
ING INF04 Automatic
ING INF05 Information processing systems

Art. 3
Professional profile and work opportunities

Aerospace and Astronautical Engineer
function in a work context:
Master's Degree Graduates in Aerospace Engineering will be able, in an international working context, to analyse and design complex components, systems and processes, to conduct experiments and to analyse and understand the results, to understand the impact of engineering solutions on the social and environmental context, aware of their professional and ethical responsibilities. They will be able to optimize system performance, manage innovation and production development, designing and implementing innovative solutions in response to specific needs. Furthermore, they will be able to interact correctly and effectively with specialists and non-specialists also through the elaboration, presentation and exchange of technical reports related to the activities relevant to their competences. The Master's Degree Aerospace Engineer will play a leading role within a team, contributing significantly to: - the analysis, design, engineering, production, experimental characterization, and operation and maintenance of systems and components in compliance with the particularly stringent requirements of aerospace engineering: high aerodynamic efficiency, high performance, operation in critical environments and situations, weight reduction with attention to safety and reliability.
Master's Degree Graduates will also be able to take on managerial roles in industries or certification entities that are not exclusively aerospace.
skills associated with the function:
The Master's Degree Course in Aerospace Engineering aims to train engineers for a highly competitive and interdisciplinary international context, with high technological content and in continuous evolution. The master's degree course therefore aims to train the professional figure of a versatile engineer, able to fit into highly qualified and rapidly developing production realities.
During the training course, the skills and tools for the analysis of the classic problems of aerospace engineering will be acquired, integrating knowledge already acquired in the first level degree with further theoretical and practical notions in the characterizing and related sectors, to solve complex problems in the fields of fluid dynamics, flight mechanics, aerospace structures and technologies, aerospace plants and systems, aerospace propulsion. Solid methodological, scientific and technical knowledge will be developed, as well as systems and technological skills so to be able to combine basic knowledge with specific professionalizing skills. Transversal communication-relational,

organisational-management and planning skills will be acquired. It will provide the opportunity to familiarize yourself with basic concepts useful for understanding the regulatory constraints that limit the engineering activity, providing tools for a more aware interaction with the professional world.
It should be emphasized that the preparation of the aerospace engineer has a highly interdisciplinary nature, such as to allow the graduate to enhance the specificity of his knowledge also in other engineering sectors.

employment opportunities:

The classic employment opportunities for Master's Degree graduates in Aerospace Engineering are the aerospace industry, industries for the construction and operation of fast means of transport, institutions and companies for the production and operation of machines, plants and equipment where fluid dynamics, lightweight structures, advanced modelling capability, system control, advanced technologies are relevant, aerospace and air traffic control certification entities, the military air force and other aeronautical industries, companies using aerospace systems for application purposes (from airlines to companies for research on the territory), engineering companies, free profession.

Researcher and technician graduated in industrial engineering and information sciences

function in a work context:

Master's Degree Graduates in Aerospace Engineering will be able, in an international context, to study and research innovative solutions for complex components, systems and processes, to conceive and conduct experiments and to analyse and interpret the results, to understand the impact of engineering solutions on the social and environmental context, aware of their professional and ethical responsibilities. They will be able to optimize the performance of components and systems by designing and implementing innovative solutions in response to specific needs. Furthermore, they will be able to interact correctly and effectively with specialists and non-specialists also through the elaboration, presentation and exchange of technical reports related to the activities relevant to their competences. They will have the cognitive tools to allow continuous and effective updating of their skills, also through the consultation of the relevant technical/scientific literature.
They will have a solid basic preparation that will allow them to face the demanding path of theoretical and applied research, also playing a leading role within research groups.

skills associated with the function:

The Master's Degree Course in Aerospace Engineering aims to train engineers for a highly competitive and interdisciplinary international context, with a solid basic education, essential for entering the world of research.
During the training course, students will acquire the skills and tools for analysing classic complex problems of aerospace engineering, in the fields of fluid dynamics, flight mechanics, aerospace structures and technologies, aerospace plants and systems, and aerospace propulsion. They will develop solid methodological, scientific and technical knowledge, and transversal communication-relational, organizational-managerial and planning skills.
It should be emphasized that the preparation of the aerospace engineer has a highly interdisciplinary character, such as to allow the recent graduate to exploit the specificity of his knowledge also in other sectors of the world of research.

employment opportunities:

The Master's Degree in Aerospace Engineering aims to provide students with the skills and solid methodological skills to operate in Research areas diversified by context and purpose, such as:
1) in the research and development sector in national and international aerospace industries or in research centres in the sector;

2) in public agencies, in the air force and space agencies;
3) in public and private bodies for testing, aircraft certification, air traffic control;
4) in airlines, in manufacturing or service companies, or in engineering companies.
In this context, job opportunities are open to Master's Degree graduates in Aerospace Engineering that extend well beyond regional and national limits.

Art. 4
Admission requirements and knowledge required for access to the Degree Program[1]

Enrolment in the Master's Degree in Aerospace Engineering requires the possession of a Degree, including the one obtained according to the provisions of the Ministerial Decree 509/1999, or a three-year university diploma or other equivalent qualification obtained abroad.
The enrolment in the master's degree course in Aerospace Engineering, in compliance with article 6 paragraph 2 of the D.M. 270/06 and with methods defined by the Didactic Coordination Commission in the Study Program Didactic Regulations, requires specific access criteria concerning the possession of minimum curricular requirements and the mandatory verification of the adequacy of the student's personal preparation.
In particular, the curricular requirements require having obtained a degree in the class of degrees in Industrial Engineering L-9 or an equivalent qualification, or having obtained at least 84 credits in specific scientific-disciplinary sectors, as follows:

SSD	**CFU**
ING-INF/05 Information processing systems MAT/03 Geometry MAT/05 Mathematical analysis MAT/07 - Mathematical physics CHIM/07 Chemical foundations of technologies FIS/01 Experimental physics FIS/03 Physics of matter SECS-S/02 - Statistics for experimental and technological research ING-IND/15 Design and methods of industrial engineering	42
ICAR-08 Science of Construction ING-IND/03 Flight mechanics ING-IND/04 Aerospace constructions and structures ING-IND/05 Aerospace plants and systems ING-IND/06 Fluid dynamics ING-IND/07 Aerospace propulsion	42 <u>of which at least 18 credits in the following sectors</u>: ING-IND/03 Flight mechanics ING-IND/04 Aerospace constructions and structures ING-IND/05 Aerospace plants and systems

[1] Artt. 7, 13, 14 of the University Didactic Regulations.

ING-IND/08 Machines ING-IND/10 Industrial technical physics ING-IND/16 - Processing technologies and systems ING-IND/22 - Science and technology of materials ING-IND/31 Electric Engineering	ING-IND/06 Fluid dynamics ING-IND/07 Aerospace propulsion

The possession of the curricular requirements and the adequacy of the student's personal preparation for admission are ascertained by examining the graduate's university career and/or by verification tests according to methods defined in the Didactic Regulations of the Master's Degree Course.
These requirements include, among other things, the documented ability to use correctly, in written and oral form, at least one language of the European Union in addition to Italian, also with reference to disciplinary lexicons. In particular, since in order to obtain the master's degree the student must be able to use fluently a language of the European Union, in addition to the Italian language, the regulation provides for students who do not have the certification of knowledge of a language of the European Union at least at level B2 of QCER the obligation to include in the study plan a number of credits for 'Additional linguistic knowledge' adequate to guarantee the achievement of this level of knowledge.

Art. 5
Procedures for access to the Degree Course

The CCD of the Degree Program normally regulates the admission criteria and any scheduling of enrolments, except in cases subject to different provisions of law[2].
Admission to non-single-cycle Master's Degree Courses requires, pursuant to Art. 6 of the Ministerial Decree March 16, 2007 (Institution Decree of Master's Degree Classes), the verification of possession of the curricular requirements specified in the Didactic Regulations of the Master's Degree Course, as well as the verification of the adequacy requirements of the student's personal preparation. Verification of personal preparation is mandatory in any case, and can be accessed only by students who meet the curricular requirements.
The Didactic Coordination Commission of the Master's Degree Course will evaluate the possession of the curricular requirements that are deemed necessary for adequate attendance of the Master's Degree Course, analysing the student's curriculum in detail. The Didactic Coordination Commission of the Course of Study will be able to identify, justifying them, any equivalences of credits of scientific disciplinary sectors different from those listed in the previous table.
The possession of the curricular requirements is automatically satisfied by graduates in Aerospace Engineering at the University of Naples Federico II.
Enrolment in the Master's Degree Course is not permitted in the absence of the minimum curricular requirements specified in article 4. In this case, the CCD, possibly making use of a special preliminary commission, evaluates the curricular requirements possessed by the candidate and recognizes the credits in whole or in part. The CCD therefore establishes the curricular integrations that the student will have to carry out before enrolment, pursuant to art. 6 paragraph 1 of the D.M. 16 March 2007, by enrolling in single teaching courses activated by the University and passing the related exams,

[2] National programmed access is regulated by L. 264/1999 and subsequent amendments and supplements.

pursuant to art. 16 paragraph 6 of the RDA (see: http://www.unina.it/-/5601348-registration-ai-corsi-singoli).

Requirements of adequacy of the student's personal preparation

The art. 6 paragraph 2 of the D.M. 16 March 2007 establishes the verification of the adequacy of the student's personal preparation, for the purposes of admission to the Master's Degree Course.
The Didactic Coordination Commission regulates, according to guidelines uniformly established for all Master's Degree Courses in Engineering of the Polytechnic School and Basic Sciences, the procedures for verifying the adequacy of the student's personal preparation.
Are exempt from this verification students whose average score (out of thirty) obtained in the exams for the achievement of the Degree which gives access to the Master's Degree Course - weighted on the basis of the relative amounts in credits - is not less than 24.
Requests for admission to the Master's Degree Course by students who do not meet the criteria for the automatic admission will be examined by the CCD which will evaluate the admissibility of the request with unquestionable judgment, establishing any fulfilments by the interested student for the purposes of admission to the Course. The CCD will be able to examine the curriculum followed by the interested student, possibly taking into consideration the marks obtained in characterizing courses or in courses considered of particular relevance for the purposes of the successful execution of the Master's Degree course, or by arranging assessment methods (interviews or tests) to verify the adequacy of the student's personal preparation, or by adopting the method envisaged for curricular integrations.

Art. 6
Teaching activities and CFU

Each training activity, prescribed by the CdS detail sheet, is measured in CFU. Each CFU corresponds to 25 hours of overall training commitment[3] per student and includes the hours of teaching activities specified in the curriculum as well as the hours reserved for personal study or other individual training activities.
For the Degree Program covered by this Didactic Regulations, the hours of teaching specified in the curriculum for each CFU, established in relation to the type of training activity, are as follows [4]:
- Lecture or exercise (in laboratory or classroom): 8 hours per CFU;
- Seminar: 8 hours per CFU;
- Practical laboratory or fieldwork: 8 hours per CFU

For internship activities, each credit corresponds to 25 hours of overall training commitment [5].
The CFU corresponding to each training activity acquired by the student is awarded by satisfying the assessment procedures (examination, pass mark) indicated in the Course sheet relating to the course/activity attached to these Didactic Regulations.

[3] According to Art. 5, c. 1 of Italian Ministerial Decree No 270/2004, "25 hours of total commitment per student correspond to university training credits; a ministerial decree may justifiably determine variations above or below the aforementioned hours for individual classes, by a limit of 20 per cent".
[4] The number of hours considers the instructions in Art. 6, c. 5 of the RDA: "of the total 25 hours, for each CFU, are reserved: a) 5 to 10 hours for lectures or guided teaching exercises; b) 5 to 10 hours for seminars; c) 8 to 12 hours for laboratory activities or fieldwork, except in the case of training activities with a high experimental or practical content, and subject to different legal provisions or different determinations by DD.MM.".
[5] For Internship activities (Inter-ministerial Decree 142/1998), subject to further specific provisions, the number of working hours equal to 1 CFU may not be less than 25.

Art. 7
Description of teaching methods

The didactic activity is carried out in modality “Conventional Degree Programs”.
If necessary, the CCD decides which subjects also include teaching activities offered online.
Some lectures may also take place in seminar form and/or involve classroom exercises, language and computer laboratories.
Detailed information on how each course is conducted can be found on the course sheets.

Art. 8
Testing of training activities[6]

1. The CCD, within the prescribed regulatory limits[7], establishes the number of examinations and other means of assessment that determine the acquisition of credits. Examinations are individual and may consist of written, oral, practical, graphical tests, term papers, interviews, or a combination of these modes.
2. The examination procedures published in the course sheets and the examination schedule will be made known to students before the start of classes on the Department's website.[8]
3. Examinations are held subject to booking, which is made electronically. In case the student is unable to book an exam for reasons that the President of the Board considers justifiable, the student may still be admitted to the examination, following those students already booked.
4. Before examination, the President of the Board of Examiners verifies the identity of the student, who must present a valid photo ID.
5. Examinations are marked out of 30. Examinations involving an assessment out of 30 shall be passed with a minimum mark of 18; a mark of 30 may be accompanied by honours by a unanimous vote of the Board. Examinations are marked out of 30 or with a simple pass mark. Assessments following tests other than examinations are marked out with a simple pass mark.
6. Oral exams are open to the public. If written tests are scheduled, the candidate has the right to see his/her paper(s) after correction.
7. The University Didactic Regulations govern Examination Boards [9].

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[6] Article 22 of the University Didactic Regulations.

[7] Pursuant to the DD.MM. 16.3.2007 in each Degree Programs the examinations or profit tests envisaged may not be more than 20 (Bachelor's Degrees; Art. 4. c. 2), 12 (Master's Degrees; Art. 4, c. 2), 30 (five-year single-cycle Degrees) or 36 (six-year single-cycle Degrees; Art. 4, c. 3). Pursuant to the RDA, Art. 13, c. 4, "the assessments that constitute an eligibility evaluation for activities referred to in Art. 10, c. 5, letters c), d), and e) of Ministerial Decree no. 270/2004, including the final examination for obtaining the degree, are excluded from the calculation." For Master's Degree Program and single-cycle Master's Degree Program, however, pursuant to the RDA, Art. 14, c. 7, "the assessments that constitute a progress evaluation for activities referred to in Art.10, c. 5, letters d) and e) of Ministerial Decree no. 270/2004 are excluded from the exam count; the final examination for obtaining the Master's Degree and single-cycle Master's Degree is included in the maximum number of exams".

[8] Reference is made to Art. 22, c. 8, of the University Teaching Regulations, which states that "the Department or School ensures that the dates for progress assessments are published on the portal with reasonable advance notice, which normally cannot be less than 60 days before the start of each academic period, and that an adequate period of time is provided for exam registration, which is generally mandatory."

[9] Reference is made to Art. 22, paragraph 4 of the RDA according to which "Examination Boards and other assessments committees are appointed by the Director of the Department or by the President of the School when provided for in the School's Regulations. This function may be delegated to the CCD Coordinator. The Commissions comprise of the President and, if necessary, other professors or experts in the subject. In the case of active courses, the President is the course instructor, and in such cases, the Board can validly make decisions even in the presence of the President alone. In other cases, the President is a professor identified at the time of the Board's appointment. In the comprehensive evaluation of the overall performance at the conclusion of an integrated course, the professors in charge of the coordinated modules participate, and the President is appointed when the Commission is appointed.”

Art. 9
Course structure and syllabus

1. The legal duration of the Degree Course is 2 years. It is also possible to enrol, based on the contract, in compliance with the provisions of Article 24 of the RDA and according to the criteria and procedures defined in the following paragraph.
2. The student must acquire 120 CFU[10], attributable to the following Types of Training Activities (TAF):
   B) characterising,
   C) related or complementary,
   D) at the student's choice[11],
   E) for the final exam,
   F) further training activities.
3. The degree is awarded after having acquired 120 ECTs by passing examinations, not exceeding 12, including the final exam, and the performance of the other educational activities.
   Unless otherwise provided for in the legal framework of University studies, examinations taken as part of basic, characterising, and related or supplementary activities, as well as activities chosen autonomously by the student (TAF D) are taken into consideration for counting purposes. Examinations or assessments relating to activities independently chosen by the student may be taken into account in the overall calculation corresponding to one unit[12]. Tests constituting an assessment of suitability for the activities referred to in Article 10, paragraph 5, letters d) and e) of Ministerial Decree 270/2004[13] are excluded from the count. Integrated courses comprising two or more modules are subject to a single examination.
4. In order to acquire the CFU relating to independent choice activities, the student is free to choose among all the Courses offered by the University, provided that they are consistent with the training project. This consistency is assessed by the Didactic Coordination Commission. Also, for the acquisition of the CFU relating to autonomous choice activities, the "passing the exam or other form of profit verification" is required (Art. 5, c. 4 of Ministerial Decree 270/2004).
5. The study plan summarises the structure of the Degree Program, listing the envisaged teachings broken down by course year and, in case, by curriculum. At the end, the propedeuticities envisaged by the Degree Program are listed. The study plan offered to students, with an indication of the scientific-disciplinary sectors and the area to which they belong, of the credits, of the type of educational activity, is set out in Annex 1 to these Didactic Regulations.

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[10] The total number of CFU for the acquisition of the relevant degree must be understood as follows: six-year single-cycle Degree, 360 CFU; five-year single-cycle Degree, 300 CFU; Bachelor's Degree, 180 CFU; Master's Degree, 120 CFU.

[11] Corresponding to at least 12 ECTs for Bachelor's Degrees and at least 8 CFU for Master's Degrees (Art. 4, c. 3 of Ministerial Decree 16.3.2007).

[12] Pursuant to the D.M. 386/2007.

[13] Art. 10, c. 5 of Ministerial Decree. 270/2004: "In addition to the qualifying training activities, as provided for in paragraphs 1, 2 and 3, Degree Programs shall provide for: a) training activities autonomously chosen by the student as long as they are consistent with the training project [TAF D]; b) training activities in one or more disciplinary fields related or complementary to the basic and characterising ones, also with regard to context cultures and interdisciplinary training [TAF C]; c) training activities related to the preparation of the final exam for the achievement of the degree and, with reference to the degree, to the verification of the knowledge of at least one foreign language in addition to Italian [TAF E]; d) training activities, not envisaged in the previous points, aimed at acquiring additional language knowledge, as well as computer and telematic skills, relational skills, or in any case useful for integration in the world of work, as well as training activities aimed at facilitating professional choices, through direct knowledge of the job sector to which the qualification may give access, including, in particular, training and guidance programs referred to in Decree no. 142 of 25 March 1998 of the Ministry of Labour [TAF F]; e) in the hypothesis referred to in Article 3, paragraph 5, training activities relating to internships and apprenticeships with companies, public administrations, public or private entities including those of the third sector, professional orders and colleges, on the basis of appropriate agreements".

6. Pursuant to Art. 11, paragraph 4-bis, of Ministerial Decree 270/2004, it is possible to obtain the Degree according to an individual study plan that also includes educational activities different from those specified in the Didactic Regulations, as long as they are consistent with the CdS detail sheet of the academic year of enrollment. The individual study plan is approved by CCD.

Art. 10
Attendance requirements[14]

1. In general, attendance of lectures is a) strongly recommended but not compulsory.
   In the case of individual courses with compulsory attendance, this option is indicated in the relevant Teaching course sheet available in Annex 2.
2. If the lecturer envisages a different syllabus modulation for attending and non-attending students, this is indicated in the individual Teaching course sheet published on the CdS web page and on the teacher's UniNA website.
3. Attendance at seminar activities that award training credits is compulsory. The relative modalities for the attribution of ECTs are the responsibility of the CCD.

Art. 11
Prerequisites and prior knowledge

1. The list of incoming and outgoing propedeuticities (necessary to sit a particular examination) can be found at the end of Annex 1 and in the teaching/activity course sheet (Annex 2).
2. Any prior knowledge deemed necessary is indicated in the individual Teaching Schedule published on the course webpage and on the teacher's UniNA website.

Art. 12
Degree Program Calendar

The Degree Program calendar can be found on the Department's website well before the start of the activities (Art. 21, c. 5 of the RDA).

Art. 13
Criteria for the recognition of credits earned in other Degree Programs in the same Class[15]

For students coming from Degree Programs of the same class, the Didactic Coordination Commission ensures the full recognition of CFU, when associated with activities that are culturally compatible with the training Degree Program, acquired by the student at the originating Degree Program, according to the criteria outlined in Article 14 below. Failure to recognise credits must be adequately justified. It is without prejudice to the fact that the number of credits relating to the same scientific-disciplinary sector directly recognised by the student may not be less than 50% of those previously achieved.

[14] Art. 22, c. 10 of the University Didactic Regulations.
[15] Art. 19 of the University Didactic Regulations.

Article 14

Criteria for the recognition of credits acquired in Degree Programs of different classes, in university or university-level Degree Programs, through single courses, at online Universities and in international Degree Programs[16]; criteria for the recognition of credits acquired in extra-curricular activities

1. With regard to the criteria for the recognition of CFU acquired in Degree Programs of different Classes, in university or university-level Degree Programs, through single courses, at online Universities and in International Degree Programs, the credits acquired are recognised by the CCD on the basis of the following criteria:
   - analysis of the activities carried out;
   - evaluation of the congruity of the disciplinary scientific sectors and of the contents of the training activities in which the student has earned credits with the specific training objectives of the Degree Program and of the individual training activities to be recognised.

   Recognition is carried out up to the number of credits envisaged by the didactic system of the Degree Program. Failure to recognise credits must be adequately justified. Pursuant to Art. 5, c. 5-bis, of Ministerial Decree 270/2004, it is also possible to acquire CFU at other Italian universities on the basis of agreements established between the concerned institutions, in accordance with the regulations current at the time [17].
2. Any recognition of CFU relating to examinations passed as single courses may take place within the limit of 36 CFU, upon request of the interested party and following the approval of the CCD. Recognition may not contribute to the reduction of the legal duration of the Degree Program, as determined by Art. 8, c. 2 of Ministerial Decree 270/2004, except for students who enrol while already in possession of a degree of the same level[18].
3. With regard to the criteria for the recognition of CFU acquired in extra-curricular activities, within the limit of 12 CFU the following activities may be recognised:
   - Professional knowledge, skills, and certified skills, taking into account the congruence of the activity carried out and/or of the certified skill with the aims and objectives of the Degree Program as well as the hourly commitment of the duration of the activity.
   - Knowledge and skills acquired in post-secondary-level training activities, which the University contributed to developing and implementing

Art. 15

Guidelines for enrolment in individual Degree Courses

Enrolment in individual teaching courses, provided for by the University Didactic Regulations[19], is governed by the "University Regulations for enrolment in individual teaching courses activated as part of the Degree Program"[20].

Article 16

Features and arrangements for the final examination

The Master's degree in Aerospace Engineering is obtained after passing a final examination, consisting of an evaluation by an academic committee of the master's thesis, developed by the

[16] Art. 19 of the University Didactic Regulations.

[17] Art. 6, c. 9 of the University Didactic Regulations.

[18] Art. 19, c. 4 of the University Didactic Regulations.

[19] Art. 19, c. 4 of the University Didactic Regulations.

[20] R.D. No. 348/2021.

student under the guidance of a university supervisor. The thesis involves original theoretical, and/or numerical, and/or experimental activities, carried out in a university laboratory. Activities carried out at external research laboratories, as well as at Italian and foreign companies and institutions, may contribute to the preparation of the thesis, provided they are part of an educational path guided by the university supervisor. External tutors from the academic school who have contributed to guiding the graduate student on specific topics of the educational path developed may be invited to the graduation session as co-supervisors, without being part of the Master's Degree Examination Committee. The written report and discussion may be developed in English and must demonstrate the work carried out, the competence about the topics covered, the maturity acquired, the ability to operate independently, and a good level of communication skills, including effective use of computer tools.
The final examination is taken by the candidate before a Committee chaired by the Coordinator of the Study Program and consists of the presentation of the work carried out under the guidance of a supervisor professor and the subsequent discussion with the members of the Committee. The candidate is allowed to use audio-visual support, to be publicly projected, or alternatively, to prepare a summary booklet, to be provided to each member of the Committee. At the end of the presentation, each professor can address observations to the candidate, related to the thesis topic. The presentation usually lasts about 15 minutes.

Article 17
Guidelines for traineeship and internship

1. Students enrolled in the Degree Program may decide to carry out internships or training periods with organisations or companies that have an agreement with the University. Traineeship and internship are compulsory and contribute to the award of credits for the other training activities chosen by the student and included in the study plan, as provided for by Art. 10, par. 5, letters d and e, of Ministerial Decree 270/2004[21].
2. The CCD regulates the modalities and characteristics of traineeship and internship with specific regulations.
3. The University of Naples Federico II, through the Student Traineeship Office and COINOR (www.coinor.unina.it), ensures constant contact with the world of work to offer students and graduates of the University concrete opportunities for internships and work experience and to promote their professional integration.

Article 18
Disqualification of student status[22]

A student who has not taken any examinations for eight consecutive academic years incurs forfeiture unless his/her contract stipulates otherwise. In any case, forfeiture shall be notified to the student by certified e-mail or other suitable means attesting to its receipt.

Article 19
Teaching tasks, including supplementary teaching, guidance and tutoring activities

1. Professors and researchers carry out the teaching load assigned to them in accordance with the provisions of the RDA and the Regulations on the teaching and student service duties of professors and researchers and on the procedures for self-certification and verification of actual performance[23].

[21] Traineeships ex letter d can be both internal and external; traineeships ex letter e can only be external.
[22] Art. 24, c. 5 of the University Didactic Regulations.
[23] R.D No. 2482/2020.

2. Professors and researchers must guarantee at least two hours of reception every 15 days (or by appointment in any case granted no longer than 15 days) and, in any case, guarantee availability by e-mail.
3. The tutoring service has the task of orienting and assisting students throughout their studies and of removing the obstacles that prevent them from adequately benefiting from attending courses, also through initiatives tailored to the needs and aptitudes of individuals.
4. The University ensures guidance, tutoring and assistance services and activities to welcome and support students. These activities are organised by the Schools and/or Departments under the coordination of the University, as established by the RDA in Article 8.

Article 20
Evaluation of the quality of the activities performed

1. The Didactic Coordination Commission implements all the quality assessment forms of teaching activities envisaged by the regulations in force according to the indications provided by the University Quality Presidium.
2. In order to guarantee the quality of teaching to the students and to identify the needs of the students and all stakeholders, the University of Naples Federico II uses the Quality Assurance (QA)[24] System, developed in accordance with the document "Self-evaluation, Evaluation and Accreditation of the Italian University System" of ANVUR, using:
   - surveys on the degree of placement of graduates into the world of work and on post-graduate needs;
   - data extracted from the administration of the questionnaire to assess student satisfaction for each course in the curriculum, with questions relating to the way the course is conducted, teaching materials, teaching aids, organisation, facilities.

   The requirements deriving from the analysis of student satisfaction data, discussed, and analysed by the Teaching Coordination Committee and the Joint Teachers' and Students' Committee (CPDS), are included among the input data in the service design process and/or among the quality objectives.
3. The QA System developed by the University implements a process of continuous improvement of the objectives and of the appropriate tools to achieve them, ensuring that planning, monitoring, and self-assessment processes are activated in all the structures to allow the prompt detection of problems, their adequate investigation, and the design of possible solutions.

Article 21
Final Rules

The Department Council, on the proposal of the CCD, submits any proposals to amend and/or supplement these Rules for consideration by the Academic Senate.

Article 22
Publicity and Entry into Force

1. These Rules and Regulations shall enter into force on the day following their publication on the University's official notice board; they shall also be published on the University website. The same forms and methods of publicity shall be used for subsequent amendments and additions.
2. Annex 1 (CdS structure) and Annex 2 (Teaching/Activity course sheet) are integral parts of this Didactic Regulations.

[24] The Quality Assurance System, based on a process approach and adequately documented, is designed in such a way as to identify the needs of the students and all stakeholders, and then translate them into requirements that the training offer must meet.

3. Annex 3 (Criteria for access to the Double Degree Program and the period of teaching activities abroad) and Annex 4 (Table of correspondence of teaching activities) are also integral parts of this Didactic Regulations.

ANNEX 1.2

DEGREE PROGRAM DIDACTIC REGULATIONS

AEROSPACE ENGINEERING CLASS LM-20

School: Polytechnic and Basic Sciences

Department: Industrial Engineering

Regulations in force for the academic year 2024 -25

STUDY PLAN

KEY

Type of Educational Activity (TAF):
B = Characterising
C = Related or Supplementary
D = Optional activities
E = Final examination and language knowledge
F = Further training activities

Aeronautics									
Year I									
Title Teaching	**SSD**	**Module**	**Credits**	**Hours**	**Type Activities**	**Course Modalities**	**TAF**	**Disciplinary area**	**Mandatory/ optional**
Mechanics Applied to Aerospace Engineering	ING-IND/13	single	9	72	Frontal lesson and exercises	In person	C	Related or Supplementary	One of your choice
Mathematical Methods for Engineering	MAT-05	single		72		In person			
Aerospace Advanced Structures	ING-IND/04	single	9	72	Frontal lesson and exercises	In person	B	Aerospace and Astronautical Engineering	Mandatory
Flight Dynamics and Simulation	ING-IND/03	single	9	72	Frontal lesson and exercises	In person	B	Aerospace and Astronautical Engineering	Mandatory
Reliability and risk in Aerospace Engineering	SECS-S/02	single	6	48	Frontal lesson	In person	C	Related or Supplementary	One of your choice
Economy and organization of aerospace industry	ING-IND/35	single		48	Frontal lesson	In person			
Aircraft Aerodynamics	ING-IND/06	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Avionics	ING-IND/05	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Training activities chosen by the student		single	0-15	0-120	Frontal lesson	In person	D		Training activities chosen by the student (up to 15 CFU)

Year II									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Type Activities**	**Course Modalities**	**TAF**	**Disciplinary area**	**Mandatory/ optional**
Rotary Wing Aerodynamics	ING-IND/06	single	6	48	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Four curricular training activities of your choice (up to reaching two exams of 9 CFU and two exams of 6 CFU)
Numerical and experimental methods for aircraft Design (*)	ING-IND/03	single	9	72		In person			
Unmanned Aircraft Systems (*)	ING-IND/05	single	9	72		In person			
Aerospace Constructions II	ING-IND/04	single	9	72		In person			
Structural Dynamics	ING-IND/04	single	9	72		In person			
Fluid-Structure interaction (*)	ING-IND/04	single	6	48		In person			
Air Traffic Management and Control (*)	ING-IND/05	single	9	72		In person			
Aircraft Design (*)	ING-IND/03	single	9	72		In person			
Aeroelasticity (*)	ING-IND/04	single	6	48		In person			
Aircraft on board systems (*)	ING-IND/05	single	6	48		In person			
Flight Tests(*)	ING-IND/03	single	6	48		In person			
Turbulence	ING-IND/06	single	6	48		In person			
Training activities chosen by the student (note a)		single	0-15	0-120	Frontal lesson	In person	D		Training activities chosen by the student (up to 15 CFU)
Further Training Activities (note b)		single	12		Internship and further linguistic knowledge	In person	F		Mandatory
Final test (note c)			12				E		Mandatory

(*) Courses offered exclusively in English

Fluid Dynamics/Propulsion									
Year I									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Activity Type**	**Course Modalities**	**TAF**	**Disciplinary area**	**Mandatory/ optional**
Mechanics Applied to Aerospace Engineering	ING-IND/13	single	9	72	Frontal lesson and exercises	In person	C	Related or Supplementary	One of your choice
Mathematical Methods for Engineering	MAT-05	single		72		In person			
Computational Fluid Dynamics	ING-IND/06	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Flight Dynamics and Simulation	ING-IND/03	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Reliability and risk in Aerospace Engineering	SECS-S/02	single	6	48	Frontal lesson	In person	C	Related or Supplementary	One of your choice
Economy and organization of aerospace industry	ING-IND/35	single		48	Frontal lesson	In person			
Space Propulsion(*)	ING-IND/06	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Aircraft Aerodynamics	ING-IND/06	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Training activities chosen by the student		single	0-15	0-120	Frontal lesson	In person	D		Training activities chosen by the student (up to 15 CFU)

(*) Courses offered exclusively in English

Year II									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Activity Type**	**Course Modalities**	**TAF**	**Disciplinary area**	**Mandatory/ optional**
Rotary Wing Aerodynamics	ING-IND/06	single	6	48	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Four Curricular training activities of your choice (up to reaching two exams of 9 CFU and two exams of 6 CFU)
Hypersonic Aerodynamics(*)	ING-IND/03	single	9	72		In person			
Experimental Fluid Dynamics(*)	ING-IND/06	single	9	72		In person			
Fluid-Structure interaction (*)	ING-IND/04	single	6	48		In person			
Aeroelasticity (*)	ING-IND/04	single	6	48		In person			
Space Experiments (*)	ING-IND/06	single	6	48		In person			
Fluid Dynamics Stability (*)	ING-IND/05	single	6	48		In person			
Turbulence	ING-IND/03	single	6	48		In person			
Training activities chosen by the student (note a)		single	0-15	0-120	Frontal lesson	In person	D		Training activities chosen by the student (up to 15 CFU)
Further Training Activities (note b)		single	12		Internship and further linguistic knowledge	In person	F		Mandatory
Final test (note c)			12				E		Mandatory

(*) Courses offered exclusively in English

Space									
Year I									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Activity Type**	**Course Modalities**	**TAF**	**Disciplinary area**	**Mandatory/ optional**
Mechanics Applied to Aerospace Engineering	ING-IND/13	single	9	72	Frontal lesson and exercises	In person	C	Related or Supplementary	One of your choice
Mathematical Methods for Engineering	MAT-05	single		72		In person			
Space Structures	ING-IND/04	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Space Systems(*)	ING-IND/05	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Reliability and risk in Aerospace Engineering	SECS-S/02	single	6	48	Frontal lesson	In person	C	Related or Supplementary	one of your choice
Economy and organization of aerospace industry	ING-IND/35	single		48	Frontal lesson	In person			
Space Propulsion(*)	ING-IND/06	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Space Flight Dynamics(*)	ING-IND/05	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Mandatory
Training activities chosen by the student		single	0-15	0-120	Frontal lesson	In person	D		Training activities chosen by the student (up to 15 CFU)

(*) Courses offered exclusively in English

Year II									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Activity Type**	**Course Modalities**	**TAF**	**Disciplinary area**	**Mandatory/ Optional**
Aerospace Remote Sensing Systems(*)	ING-IND/05	single	9	72	Frontal lesson	In person	B	Aerospace and Astronautical Engineering	Four Curricular training activities of your choice (up to reaching two exams of 9 CFU and two exams of 6 CFU)
Hypersonic Aerodynamics(*)	ING-IND/06	single	9	72		In person			
Space Mission Design (*)	ING-IND/05	single	9	72		In person			
Spacecraft Dynamics and Control (*)	ING-IND/05	single	6	48		In person			
Space Experiments (*)	ING-IND/06	single	6	48		In person			
Training activities chosen by the student (note a)		single	0-15	0-120	Frontal lesson	In person	D		Training activities chosen by the student (up to 15 CFU)
Further Training Activities (note b)		single	12		Internship and further linguistic knowledge	In person	F		Mandatory
Final test (note c)			12				E		Mandatory

(*) Courses offered exclusively in English

Notes

(a) The 15 credits of self-choice courses can be chosen from:

- Type B courses present in the first year in courses other than the chosen one, elective curricular courses present in all courses in the related tables, courses in Table C (automatic approval of the study plan)
- Courses delivered at the Polytechnic School or courses held within the ERASMUS framework (subject to approval of the study plan).

(b) Additional training activities usually include 3 credits for additional language skills and 9 credits for internship. However, in accordance with the regulations of the degree course, the student may request to spend a maximum of 6 credits for further language skills, a maximum of 3 credits for computer and telematic skills, a maximum of 12 credits for training and orientation internships, maximum 3 credits for other knowledges useful for entering the world of work.

Students who do not possess certification of knowledge of a European Union language at least at level B2 are required to spend 3 of the 12 credits envisaged for further training activities in the form of further language skills. Students in possession of a B2 level English certificate at the time of enrolment can request the recognition of 3 of the 12 credits envisaged for further training activities in the form of Additional language skills. Further knowledge can be acquired through intramoenia internship or extramoenia internship. The latter is carried out at companies, research centres or other public and/or private bodies and aims at acquiring specialist knowledge with the support from personnel engaged in the design, production and management of production or research plants in order to have a first approach to work.

The intramoenia internship can be carried out at the university's research laboratories in order to acquire specialist knowledge by supporting the teaching and research staff in conducting research and development activities. In all cases, the activity can be preparatory to the thesis work and the fulfilment of these tasks must be certified through the acquisition of the AC model, countersigned by the professor responsible for the internship activity or by the degree thesis supervisor.

(c) The thesis work can also be carried out in companies in Italy or abroad. It will always be carried out under the direct and full responsibility of a Professor of the Engineering Didactic Area of the University of Naples Federico II (the procedures for assigning the student to the Supervisor are specified in the Didactic Regulations of the Study Course) and may, possibly, make use of the co-supervision of a Company Tutor. The procedures for assigning the Company Tutor are governed by the Didactic Regulations of the Study Course as well as by Specific Agreements.

Satisfaction of the above conditions provides a study plan of automatic approval, for which the student must give the Secretariat, within the time schedules established for the presentation of the Study Plan by the Didactic Regulations, only the communication of the selected specialization ("Aeronautics", "Fluid dynamics/ Propulsion" or "Space"); different solutions can be followed upon presentation of an individual study plan to the Student Secretariat of the Engineering Didactic Area of the Polytechnic and Basic Sciences School, exclusively within the terms established by the Didactic Regulations. The Didactic Coordination Commission of the Master's Degree Course reserves the right to decide on their approval or not on the basis, as established by law, of a clear motivation expressed by the student.

Finally, it should be noted that, in all cases, an exam can be taken only after the relevant course has been delivered in the Academic Year in which the Study Plan is presented.

TABLE C									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Type Activities**	**Course Modalities**	**TAF**	**Disciplinary area**	**Semester**
Aerospace Design Project(*)	ING-IND/04	Aerospace Design Project: structures	3	24	Frontal lesson	In person	D		Annual
	ING-IND/05	Aerospace Design Project: systems	3	24		In person	D		
	ING-IND/06	Aerospace Design Project: fluid dynamics	3	24		In person	D		
Geometrical Modelling and virtual Prototyping for Aerospace Engineering	ING-IND/15	single	9	72	Frontal lesson	In person	D		Semester I
Combustion and Fluid Dynamics of reactive systems (From Chemical Engineering Master's Degree)	ING-IND/25	single	6	48	Frontal lesson	In person	D		Semester I
Statistical lab for industrial data analysis (*)	SECS-S/02	single	9	72	Frontal lesson	In person	D		Semester I
Machine Learning and big data (From Autonomous Vehicle Engineering Master's Degree) (*)	ING-INF/05	single	9	72	Frontal lesson	In person	D		Semester II
Radar Systems (from Telecommunication Engineering Master's Degree)	ING-INF/03	single	9	72	Frontal lesson	In person	D		Semester I
Signal and Image Processing (from Telecommunication Engineering Master's Degree)	ING-INF/03	single	9	72	Frontal lesson	In person	D		Semester II
Design Principles for wind and ocean renewable energy systems	ING-IND/03	single	6	48	Frontal Lesson	In person	D		Semester I
Electrical basics for Aeronautics	ING-IND/32	single	6	48	Frontal Lesson	In person	D		Semester II
Electro-magnetic basics for Space applications	ING-INF/02	single	9	72	Frontal Lesson	In person	D		Semester I
Experimental Vibroacoustics (*)	ING-IND/04	single	6	48	Frontal Lesson	In person	D		Semester II
Impact dynamics (*)	ING-IND/04	Single	6	48	Frontal Lesson	In person	D		Semester II
Elastodynamics and structural health monitoring principles (*)	ING-IND/04	Single	6	48	Frontal Lesson	In person	D		Semester II
Hybrid Propulsion Systems (from Mechanical Engineering for the	ING-IND/08	Single	6	48	Frontal Lesson	In person	D		Semester II

TABLE C									
Title Teaching	**SSD**	**Module**	**CREDITS**	**Hours**	**Type Activities**	**Course Modalities**	**TAF**	**Disciplinary area**	**Semester**
Environment and Energy Master's Degree)									
Aircraft Operations(*)	ING-IND/03	Single	6	48	Frontal Lesson	In person	D		Semester I
Launch and Re-entry vehicle design and Dynamics (*)	ING-IND/03	Single	6	48	Frontal Lesson	In person	D		Semester II
Sustainable Material Chemistry for Aerospace and Energy	CHIM/07	Single	9	72	Frontal Lesson	In person	D		Semester I

(*) Courses offered exclusively in English

List of propaedeuticities

ANNEX 2.1

DEGREE PROGRAM DIDACTIC REGULATIONS

AEROSPACE ENGINEERING CLASS LM-20

School: Polytechnic and Basic Sciences School

Department: Industrial Engineering

Regulations in force for the academic year 2024-2025

Course: **Aircraft aerodynamics**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/06	**CREDITS:** 9
Course year: I	**Type of Educational Activity: B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the fluid dynamics and its applications in engineering. Starting from the balance equations of the continuous fluid [...], they include the constitutive relationships, the dynamics of the vorticity, the potential and viscous flow fields, the compressible and non-compressible flow fields, the interaction between fluid currents and rigid bodies [...] the boundary layers, [...] the shock waves, [...] the turbulence. The fundamental topics of the sector are completed by the peculiar and multiple numerical simulation techniques [...] and the methods of investigation of stability and transition of the flow fields as well as aerodynamic design [...].	
Learning objectives: The course aims at completing the preparation of students in the applied aerodynamic field and providing them with methods for the solution of aerodynamic problems.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Oral test.	

Course: **Reliability and risk in aerospace engineering**	**Teaching Language:** Italian
SSD (Subject Areas): SECS-S/02	**CREDITS:** 6
Course year:I	**Type of Educational Activity: C**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular of engineering (reliability, statistical quality control) and biomedical sciences (anthropometrics, biometrics, medical statistics). The main fields of application concern technology, safety, the environment, the territory, production processes, products, natural resources	
Learning objectives: The objective of the course is providing the students with concepts, methodology, and tools useful for developing reliability and maintainability analyses of components and complex systems as well as for performing risks assessments, including economic ones, associated with use, management, and design thereof.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written and oral test	

Course: **Mathematical methods for engineering**	**Teaching Language:** Italian	
SSD (Subject Areas): MAT/05		**CREDITS:** 9
Course year:I	**Type of Educational Activity:C**	
Teaching Methods: **In person.**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector is interested in teaching - training and research activities in the field of Mathematical Analysis in all its articulations (harmonic, convex, functional, linear and non-linear); differential equations, ordinary and partial derivatives, the calculus of variations and the theory of functions; of measure theory. The teaching skills of this sector also concern all the institutional aspects of basic mathematics which refer to the macro-sector 01A Mathematics.		
Learning objectives: The course aims to provide basic knowledge of Mathematical Analysis required to formulate mathematical models of engineering and scientific problems.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Oral test.		

Course: **Advanced aerospace structures**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/04	**CREDITS:** 9
Course year:I	**Type of Educational Activity:B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The teaching contents take up those of the sector declaration ING-IND/04 with particular reference to the technological, structural and constructive skills related to atmospheric and space vehicles, such as fixed-wing aircraft, launchers, satellites, stations space, just to name a few. In detail, the teaching covers the skills concerning static and dynamic analysis up to impact phenomena, active and passive control of structures and materials. Problems of structural safety in the aeronautical and space fields, such as fatigue, reliability and passive safety, are discussed.

Learning objectives:

The course aims to provide the essential concepts for numerical structural calculation with finite elements, both for statics and for structural dynamics. The basic elements for the discretization and modeling of the structural behavior of typical aerospace structures are presented to allow future aerospace engineers to analyze and to solve complete structural components with examples of specific practical applications. Problems related to the evaluation of the non-linear behavior of structures, both from a static and dynamic point of view, are also addressed, taking into account both geometric non-linearities and those related to the non-linear behavior of materials.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test.

Course: **Applied mechanics to aerospace engineering**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/13	**CREDITS:** 9
Course year:I	**Type of Educational Activity:C**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector includes the cultural and professional aspects inherent the study of mechanical systems through the methodologies of theoretical mechanics. The typology of the machines studied is completely general; however, extensive reference is made to driving and operating machines, mechanical devices, automatic machines and robots, vehicles and biomechanical systems. In particular, both the analysis and the synthesis of the mechanical behavior of the machines and systems indicated above are studied. The analysis is articulated in the modeling, simulation, regulation and control of the same; the synthesis is aimed at their functional design. Particular emphasis is placed on the study of vibratory and tribological phenomena of machines. Strong interrelationships are implemented with the methodologies and algorithms developed in the fields of design and methods of industrial engineering, mechanical design and construction of machines and fluid dynamics.

Learning objectives:

The course aims to resume and develop some topics of analytical mechanics to provide the basic knowledge for the understanding and analysis of the problems that arise in the functioning of the "dynamic machines" characterized by mechanical elements in relative motion. The most common mechanical systems, adopted in the industrial and aerospace fields, are described and studied.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test.

Course: **Economics and organization of the aerospace sector**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/35	**CREDITS:** 6
Course year:I	**Type of Educational Activity:C**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

MICROECONOMICS: the nature of microeconomics; supply and demand; the consumer and market demand; the company, its technology and its costs; market structure, perfect competition, monopoly and oligopoly.
MACROECONOMICS: the nature of macroeconomics; the macroeconomic circuit; the functions of consumption, saving and investment; real, monetary and general macroeconomic equilibrium.
INTRODUCTION TO THE STUDY OF THE AERONAUTICAL SECTOR: The economic nature of the innovative process of the aeronautical sector; Technological innovation and production organization in the aeronautical sector; The industrial organization of the aeronautical sector. The network of companies in the aeronautical sector. Industrial organization and subcontracting relationships.

Learning objectives:

The course aims to:
• Provide fundamental concepts and models relating to the behavior of economic actors with reference to micro and macroeconomic systems.
• Provide basic knowledge for the analysis of operational and strategic business decisions starting from data on business costs and revenues.
• Provide basic knowledge on the management and planning of organizations.
• Address the fundamental elements of the economy and business organization with reference to the aeronautical sector.
• To transfer the concept of complexity of the aeronautical sector in its technological, organizational and economic dimensions.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test.

Course:	Teaching Language:
Avionics	Italian

SSD (Subject Areas):	CREDITS:
ING-IND/05	9

Course year:I	Type of Educational Activity:B

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies individual subsystems and on-board systems of aeronautical and space vehicles capable of ensuring the operational life of the system and the ground systems necessary for mission control and experimentation. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; ground and flight testing of aeronautical systems; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation necessary for trajectory surveying and data acquisition and transmission; the methodologies, subsystems and instrumentation needed for special applications.

Learning objectives:

The student will acquire knowledge of the operating principles, the design and integration problems of the avionics components on board an aircraft. In particular, the problems relating to air navigation will be investigated. The student will have to acquire understanding of the main engineering aspects related to the use of inertial systems, air data systems, aerial radio navigation systems and satellite navigation systems (GPS, Glonass, Galileo). Reference concepts for aerial surveillance will also be defined. In addition, he / she will have to manage measurement integration techniques such as the Kalman Filter.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test

Course:	Teaching Language:
Flight dynamics and flight simulation	Italian

SSD (Subject Areas):	CREDITS:
ING-IND/03	9

Course year:I	Type of Educational Activity:B

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the flight mission, the manual and/or automatic control, the flight qualities of vehicles operating in the atmospheric environment. These issues play a fundamental role in characterizing the safety and management of an aerospace vehicle and its mission. The competences of the sector concern the stability, the control, the study of the trajectory and the problems of the man/machine interface of the aforesaid class of vehicles. The analysis and verification methodologies, conducted through modeling and simulation, play a strongly unifying and qualifying role within the aforementioned topics.

Learning objectives:

The main objective of the course is to provide all elements to numerically simulate the aircraft motion in atmospheric flight. Prediction of loads, spins, inertial coupling and effect of gusts are in the scope of the course.
The modern flight simulation techniques are also discussed. The course introduces the use of simulation codes implementing the numerical resolution of 6-degrees-of-freedom airplane equations of motion. Some simulation-related special topics are also presented, such as the graphic representation of flight, and the interactive management of flight control systems in pilot-in-the-loop simulations.
The course introduces to the principles underlying the dynamic stability of the airplane and gives the elements needed to evaluate aircraft flying qualities. Students are guided to the comprehension of the main concepts through practical examples. Proposed exercises are solved by making use of Matlab and Simulink.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test and project discussion.

Course: **Fluid-structure interaction**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/04	**CREDITS:** 6
Course year:II	**Type of Educational Activity:B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The teaching contents take up those of the ING-IND/04 sector declaration with particular reference to the technological, structural and constructive skills related to atmospheric and space vehicles. In detail, the teaching covers the skills concerning the study of phenomena acoustoelastics and of the fluid-structural interaction in fast means of transport.	
Learning objectives: The background of the students inside the structural aerospace engineering field will be completed by correlating several arguments. They are interpreted in a modern sense as fluid-structure interaction. The student: - will be introduced to the specific themes by using examples very close to the common engineering practice; - will acquire lexicon, tools and methods; - will learn how to manage complex and complete procedures; - will analyse if the available data and tools are suitable and enough for getting the required results.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Oral test.	

Course: **Aeroelasticity**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/04	**CREDITS:** 6
Course year:II	**Type of Educational Activity:B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The teaching contents take up those of the sector declaration ING-IND/04 with particular reference to the technological, structural and constructive skills related to atmospheric and space vehicles, such as fixed-wing aircraft, rotary-wing aircraft, launchers , satellites, space stations, to name a few classes of reference aircraft. In detail, the teaching provides the skills concerning the study of static and dynamic aeroelastic phenomena, as well as the dynamic response of aircraft and hints at the aeroelastic behavior of civil structures. Finally, the problems of active control of aeroelastic phenomena, certification and the tests necessary to achieve it are discussed.

Learning objectives:

The objective of the course is to introduce the student to the problems of the interaction of aerodynamics, inertia and elastic forces for a flexible structure and the phenomena that can result. The course will be based upon the knowledge of the finite element method and the aerodynamics of lifting surfaces and moves toward the methods of the aeroelasticity from both the numerical and the experimental point of view. The ability of setting up an experimental modal testing will be discussed, and the students will be requested to deal with ground vibration testing and identification methods. The aeroelastic approach will represent furthermore the basis for the design and multidisciplinary optimization of flexible structures.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test

Course: **Aircraft design**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/03	**CREDITS:** 9
Course year:II	**Type of Educational Activity:B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the aeromechanical project, the flight mission, the flight qualities of vehicles operating in the atmospheric environment. These issues play a fundamental role in characterizing the safety and management of an aerospace vehicle and its mission. The competences of the sector concern the preliminary design, the performances, the stability, of the aforesaid class of vehicles. The methodologies of analysis and verification, conducted through modeling and simulation, play a strongly unifying and qualifying role in the ambit of the aforementioned topics.	
Learning objectives: The course will show a complete and organic methodology for the preliminary design of transport aircraft. Starting from the design requirements, all problems concerning design of airplane components and the design of the complete aircraft will be shown. Several applications using software tools for preliminary sizing of aircraft will be performed. Application, methods, and data to enable case studies of subsonic aircraft design are provided and students will develop in group the preliminary design of a transport aircraft also enhancing their soft skill and team-working capabilities.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written and oral test and project discussion	

Course: Aerospace constructions II	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/04	**CREDITS:** 9
Course year:II	**Type of Educational Activity:** B
Teaching Methods: In person.	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The contents of the course reflect those of the SSD ING-IND/04 declaration, with particular reference to the study of composite materials and the mechanics of linear elastic fracture, with applications to the design of shell structures in the aeronautical and space sectors and to the problems of maintenance.	
Learning objectives: The course aims to deliver theoretical and practical tools for solving structural problems with composite materials for aerospace applications, by calculating the stress state in orthotropic materials, defining the failure theories and the criteria for the structural sizing. The fracture mechanics is then introduced for metallic materials. The crack propagation models are studied and the calculus criteria and sizing procedures analyzed.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: the student must realize a project concerning the course topics, must take a written test. The oral exam is not mandatory. The written test consists in a mid-term test during the course and final test at the end of the course	

Course: **Rotary wing aerodynamics**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/06	**CREDITS:** 6
Course year: II	**Type of Educational Activity:** B
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the fluid dynamics and its applications in engineering, the interaction between fluid currents and rigid bodies [...] the peculiar and multiple numerical simulation techniques [...] the aerodynamic design [...]. Significant scientific and technological applications of relevant interest are essential parts of the sector.	
Learning objectives: The aim of the course is the introduction to the Aerodynamics of the rotary wing and in particular to the study of propellers, rotors and wind turbines. Both the theoretical and technical aspects are taken care of, which lead the student to the direct experience of design. The course includes exercises that require the use of open source software, electronic tables (Excel), programs in MatLab and the use of the commercial software ANSYS-Fluent public version for students.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: oral test	

Course: **Experimental fluid dynamics**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/06	**CREDITS:** 9
Course year:II	**Type of Educational Activity:B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the fluid dynamics and its applications in engineering. […]. The peculiar and multiple techniques [...] of experimental measurement and the methods of investigation of stability and transition of flow fields complete the fundamental topics of the sector. In addition to aerodynamic and gas-dynamic design, applications of significant scientific and technological interest in thermofluid dynamics, aeroacoustics, transition and control of turbulence, motion of large masses and dispersion of pollutants are essential parts of the sector.	
Learning objectives: The course aims at providing both the theoretical background and the practical technicalities of the most used Experimental Fluid Dynamics methods. Each measurement technique is explained highlighting: the potential advantages and drawbacks; the principles of operation; the application limits and uncertainties; the implementation and integration in a real experiment.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Oral test	

Course: **Fluid dynamic stability**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/06	**CREDITS:** 6
Course year:II	**Type of Educational Activity:B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the fluid dynamics and its applications in engineering. Starting from the continuum fluid balance equations, it includes constitutive relations for Newtonian fluids, dynamics of vorticity and potential flows, compressible and non-compressible flow fields, mass and energy transport phenomena, boundary layers, wakes and jets, acoustic waves and shock, stability and transition, turbulence dynamics, passive scalars and multiphase flows. The relevant topics are completed by theoretical methodologies and numerical simulation and experimental investigation techniques. Essential parts are aerodynamic, gas-dynamic and hydro-dynamic design with applications concerning transport systems, heat transfer and combustion processes, aeroacoustics, transition and turbulence control.	
Learning objectives: The course addresses basic theories and advanced investigation methodologies to analyze flows instabilities. Inner and open shear flows are particularly investigated. Industrial problems such as the prediction of laminar-to-turbulence transition and the break-up of two-phase interface leading to atomization phenomena are some of the major application fields.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Oral test	

Course: **Aerospace design project**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/04, ING-IND/05, ING-IND/06.	**CREDITS:** 3 ING-IND/04, 3 ING-IND/05, 3 ING-IND/06.
Course year: I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

As regards the contents of the SSD ING-IND/04, the course includes the technological, structural and constructive knowledge related to atmospheric and space vehicles, such as fixed-wing aircraft, rotorcraft, launchers, re-entry vehicles, satellites, space stations, probes, etc. integrating such knowledge with those of the other SSDs. The sector provides skill concerning the study of aeroelastic phenomena, the project, the determination of the loads, the static and dynamic analysis up to the impact phenomena, the active control of the structures, the materials, the construction, the repairs and the maintenance. In particular, the sector studies all the problems of structural safety in the aeronautical and space fields, such as fatigue, reliability and passive safety.

As regards the contents of SSD ING-IND/05, the course is focused on the study of aeronautical and space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and on-board systems of aeronautical and space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, power generation and distribution, avionics and on-board electronic systems, data transmission and processing information, thermal and air conditioning control, etc.) and the ground systems necessary for mission control and experimentation.

As regards the contents of the SSD ING-IND06, the teaching resumes, integrating them with those of the other SSDs, the skills concerning the motion of fluids and its applications in the field of engineering [....] and the related theoretical methodologies and numerical simulation and experimental investigation techniques. Essential parts are aerodynamic, gas-dynamic and hydro-dynamic design with applications concerning transport systems, heat transfer and combustion processes, aeroacoustics, transition and turbulence control.

Learning objectives:

This course takes its motivation from the strong interest and growing need of the industrial world in a multidisciplinary approach to engineering problems and design. To answer these requests, this course is aimed to contribute to some specific learning outcomes. The class will be subdivided in group of students. Each group will autonomously select a specific project to be completed by the end of the course. Each student is forced to acquire ability in working in a team environment, improving his/her project management and communication skills, to identify, formulate, and solve engineering problems, to explore and propose solutions, to design a system, or a component, or a process to meet requirements and specifications, managing engineering standards. The students will also learn how to communicate effectively in oral and written form.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test and project discussion.

Course: **Aerospace remote sensing systems**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/05	**CREDITS:** 9
Course year: II	**Type of Educational Activity: B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies aeronautical and space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. These are aspects of the study: the subsystems and instrumentation needed for special applications, such as remote sensing.	
Learning objectives: This course is intended to provide a basic knowledge of scientific and engineering problems related to the aerospace systems for earth observation, with particular reference to airborne and spaceborne high resolution sensors, both in the electro-optical and microwave region of the electromagnetic spectrum, and to space remote sensing mission analysis and design.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written and oral test.	

Course: **Hypersonic Aerodynamics**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/06	**CREDITS:** 9
Course year: II	**Type of Educational Activity:** B
Teaching Methods: **In person**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the fluid dynamics and its applications in engineering. Starting from the balance equations of the continuous fluid [...], they include the constitutive relationships, the dynamics of the vorticity, the potential and viscous flow fields, the compressible and non-compressible flow fields, the interaction between fluid currents and rigid bodies [...] the boundary layers, […] the shock waves, […] the turbulence. The fundamental topics of the sector are completed by the peculiar and multiple numerical simulation techniques [...] and the methods of investigation of stability and transition of the flow fields as well as aerodynamic design [...].	
Learning objectives: The course provides the students with fundamental knowledge on physical effects, classical methods, and recent advancements of hypersonic flows adopted in high enthalpy regimes typical of reentry vehicle, with the aim to fulfill the student knowledge on aerodynamic and space technologies. Specific objectives include: 1) review different hypersonic vehicles and their trajectories; 2) study the environment around hypersonic vehicles created by strong shock waves; 3) introduce students to real gas and nonequilibrium effects caused by high temperature conditions and chemical reactions; 4) study pressure and heat transfer phenomena around hypersonic vehicles in continuum and rarefied flow; 5) educate students on hypersonic experimental test facilities and measurements.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Oral test.	

Course: SPACE EXPERIMENTS	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/06		**CREDITS:** 6
Course year: II	**Type of Educational Activity: B**	
Teaching Methods: **In person.**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the motion of fluids and its applications in engineering [….] mass and energy transport phenomena, boundary layers [….]. The peculiar and multiple techniques of numerical simulation and experimental measurement and the investigation methods of stability and transition of flow fields complete the fundamental topics of the sector. Applications of significant scientific and technological interest are essential parts of the sector [...].		
Learning objectives: The student will acquire the fundamental concepts concerning the scientific and engineering problems related to the execution of experiments on board space platforms, with particular reference to the aspects concerning research in microgravity. Topics include the study of the behavior of fluids in conditions of reduced gravity, their modeling and the study of experimental techniques available on board space platforms.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Oral test.		

Course: **Space Propulsion**	**Teaching Language:** English	
SSD (Subject Areas): ING-IND/07		**CREDITS:** 9
Course year: I	**Type of Educational Activity:** B	
Teaching Methods: **In person.**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the various aspects that contribute to the research, development, construction, use and performance of propulsion systems in the aeronautical and space fields. Over the years, this complex of disciplines has assumed growing importance and a clear specificity in the aerospace sector, also due to the growing need for integration between propulsion and other aspects of aerospace vehicle design. The skills of the sector concern the fundamental aspects of the chemical-physical processes involved; the operating principles of the different types of thrusters with reference to the different types of thrusters currently used or proposed in the transatmospheric and space fields.		
Learning objectives: The course covers the fundamentals of rocket propulsion and discusses advanced concepts in space propulsion ranging from chemical to electrical engines, for launch, orbital, and interplanetary flight. Topics include analysis of requirements for typical space missions, physics and engineering of chemical thrusters (solid, liquid, hybrid bipropellant rockets, monopropellants), air-breathing hypersonic engines, and electric thrusters, including electrothermal, electrostatic, and electromagnetic thrusters. Physical and chemical modelling, as well as design and technological issues will be discussed.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Oral test.		

Course: SPACE FLIGHT DYNAMICS	**Teaching Language:** English
SSD (Subject Areas): ING-IND/05	**CREDITS:** 9
Course year: I	**Type of Educational Activity: B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and systems on board space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, etc.) and the ground systems necessary for mission control and experimentation. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; ground and flight testing of space systems; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation needed to survey trajectories and orbits and to acquire and transmit data. The sector makes use of specific investigation methodologies, such as simulation for experimental, analytical and numerical modelling

Learning objectives:

The course is aimed at introducing the methods of space flight dynamics that are applied to real space systems. Starting from the basic knowledge linked to two-body mechanics, several topics will be covered in depth, including orbit perturbations analysis and propagation methods, orbital maneuvers, orbit maintenance approaches, and interplanetary trajectories. Special emphasis will also be given to the study of relative dynamics in space and its application to distributed space systems, and to autonomous rendezvous and docking in missions such as on orbit servicing and active debris removal

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and Oral test.

Course: SPACE SYSTEMS	Teaching Language: English
SSD (Subject Areas): ING-IND/05	**CREDITS:** 9
Course year: I	**Type of Educational Activity: B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and systems on board space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, power generation and distribution, thermal control, etc.) and the ground systems necessary for control of the mission. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation needed to survey trajectories and orbits and to acquire and transmit data. The sector makes use of specific investigation methodologies, such as simulation for experimental, analytical and numerical modelling.

Learning objectives:

The course provides the basic elements for the design of a space system in response to space mission requirements and objectives, with particular concern to the subsystems on board a satellite, in terms of mathematical and physical modeling of the subsystem behavior, technologies and development examples and solutions.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test and project discussion.

Course: AIR TRAFFIC MANAGEMENT AND CONTROL	Teaching Language: English
SSD (Subject Areas): ING-IND/05	CREDITS: 9
Course year: II	Type of Educational Activity: B

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and systems on board space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, power generation and distribution, thermal control, etc.) and the ground systems necessary for control of the mission. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation needed to survey trajectories and orbits and to acquire and transmit data. The sector makes use of specific investigation methodologies, such as simulation for experimental, analytical and numerical modelling.

Learning objectives:

This course will provide a complete overview about Air Traffic Management and Air Traffic Control systems and procedures. In this framework, the aircraft is considered a component of a global traffic scenario at national, continental, and intercontinental level. The main topic discussed in the course can be summarized as follows:
Regulations; ii) Surveillance; iii) Navigation; iv) Operations; v) Weather and environmental issues; vi) Advanced topics: UAS integration, PBN, Airport Automation, and modernization. Since Air Traffic Management is developing several innovations in the last few years, a large analysis of future most important changes will be presented at the end of the course. It includes all topics accounted in the main innovation projects worldwide, i.e. Next Gen in the US and SESAR in Europe. Moreover, this course will give students knowledge of Aeronautical Communications System and Air Routes. Theoretical, technological, design, installation and operational issues will be addressed. Course aims at enabling students to manage at system level Voice Communications, Digital Communications, Aircraft Trajectory Prediction, and Mission Path Planning.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and Oral test

Course:	Teaching Language:
UNMANNED AIRCRAFT SYSTEMS	English
SSD (Subject Areas):	**CREDITS:**
ING-IND/05	9
Course year: II	**Type of Educational Activity: B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and systems on board space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, power generation and distribution, thermal control, etc.) and the ground systems necessary for control of the mission. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation needed to survey trajectories and orbits and to acquire and transmit data. The sector makes use of specific investigation methodologies, such as simulation for experimental, analytical and numerical modelling.

Learning objectives:

The course is intended to provide a basic knowledge about architecture and operation of Unmanned Aircraft Systems (UAS), dealing in particular with UAS classification, regulations, sensors and data fusion algorithms, autonomous guidance, navigation and control, communication and data links, ground stations.
Special emphasis is given to enabling technologies for autonomous flight and UAS integration in the civil airspace, such as ground-based and airborne sense and avoid systems.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and Oral test

Course: Structural dynamics	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/04	**CREDITS:** 9
Course year: II	**Type of Educational Activity: B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The contents, connected to the SSD declaration and consistent with the objectives of the course, are those linked with the dynamic analysis and active and passive control of the structures that constitute the atmospheric and space vehicles, fixed and rotary wing, launchers, re-entry vehicles, satellites, space stations, spacecrafts. Always in line with the contents of the specific declaration, the issues of structural safety in the aeronautical and space fields are also topics consistent with the training targets.	
Learning objectives: Complete knowledge of structural dynamics and identification and dynamic characterization of complex systems. These objectives are pursued both with analytical, numerical, experimental methodologies and mainly by focusing attention on the possibility of comparing these approaches to obtain an optimization of the theoretical and numerical models.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Oral exam - The student can develop a project to be discussed during the exam. This activity is optional	

Course: SUSTANAIBLE MATERIALS CHEMISTRY FOR AEROSPACE AND ENERGY	**Teaching Language:** Italian
SSD (Subject Areas): CHIM-07	**CREDITS:** 9
Course year: I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The scientific disciplinary sector is oriented towards the study of the chemical and chemical-physical fundamentals of the various fields of technology, with particular emphasis on those relating to materials, their properties and interaction with the environment, providing a synthesis of the principles common to the various categories of substances.

Learning objectives:

This course will examine innovative chemical methodologies to address the main environmental sustainability issues related to the development and use of functional materials for aerospace and energy applications, to provide students with the critical tools to address these challenges in the areas of environmental sustainability and circular economy.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral examination

Course: Combustion and Fluid Dynamics of reactive systems	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/25	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The course, in line with the declaration of the Sector, intends to frame the combustion processes in systems of practical relevance, in the context of the current energy transition; provide tools for both modeling and experimental evaluation of the main aerodynamic and reactor configurations for the use of both gaseous and liquid energy carriers in the various applications in the energy, propulsive and material transformation fields.

Learning objectives:

The course aims to provide the methodological tools and knowledge to frame combustion processes in the context of propulsion, sustainable mobility and power generation applications in order to evaluate their potential development under the constraints related to alternative fuels, pollutant emission limits and performance. Furthermore, the course defines the most relevant prototype configurations and equations describing combustion processes evolving under fixed boundary/initial conditions, analyzing their most significant parameters and most sensitive variations.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test

Course: EXPERIMENTAL VIBROACOUSTICS	**Teaching Language:** English
SSD (Subject Areas): ING-IND/04	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The teaching contents take up those of the sector declaration ING-IND/04 with particular reference to the technological, structural and constructive skills related to atmospheric and space vehicles, such as fixed-wing aircraft, rotary-wing aircraft, launchers , satellites, space stations, to name a few classes of reference aircraft. In detail, the teaching covers the skills concerning the study of experimental vibro-acoustics including the basics of acoustics and experimental structural dynamics, measurement and data processing techniques, coupled acousto-structural numerical modeling aimed at the design of the experiment and the validation of the numerical results with those measured experimentally.

Learning objectives:

The student knowledge regarding the management of dynamic phenomena where interaction of vibrating structure with confined of open air fluid emerge, will be deeply studied under the experimental point of view.
The course will introduce the student to the several instrumentation and techniques to measure and evaluate both the acoustic and the vibrational parameters and relative correlation; also the methods for the verification and updating of the related numerical model will be widely studied.
At the end of the course, the student:
*) will be introduced to the specific themes through the study of a large variety of examples very close to the common engineering practice;
*) will acquire knowledge, tools and methods for experimental measurement in the field of the course
*) will learn how to manage complex and complete experimental set-up
*) will be able to organize a test report
*) will be able to manage the verification and updating process of numerical models

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and Oral test

Course: FLIGHT TEST	**Teaching Language:** English
SSD (Subject Areas): ING-IND/03	**CREDITS:** 6
Course year: II	**Type of Educational Activity: B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the flight mission, the manual and/or automatic control, the flight qualities of vehicles operating in the atmospheric environment. These issues play a fundamental role in characterizing the safety and management of an aerospace vehicle and its mission. The skills of the sector concern the performance, stability, control and human/machine interface problems of the aforementioned vehicle class. The methods of analysis and verification, conducted through experimentation, play a strongly unifying and qualifying role in the ambit of the aforementioned topics.

Learning objectives:

The course will show all problems and procedures related to the flight test phase of aircraft with also a focus on aircraft certification process. The course will also deal with Flight Test Instrumentation (FTI) design and operational characteristics.

All the flight tests required for a complete flight test campaign useful for Aircraft certification and qualification will be shown.

Part of the course will be also linked to experience on an airfield with practical management of flight test (with preparation of flight test cards), if possible also flight test experience on-board and post-processing of flight tests data acquired with redaction of an accurate flight test report.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test and project discussion

Course: HYBRID PROPULSION SYSTEMS	Teaching Language: Italiano
SSD (Subject Areas): ING-IND/08	CREDITS: 6
Course year: I-II	Type of Educational Activity: D

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the thermodynamic, fluid dynamics, energy, ecological, technological and environmental problems of fluid machines [..]. The skills of the sector cover the design, management, diagnostics, control, environmental impact, experimentation and testing aspects [...] of internal combustion engines [...]. The sector also studies the inclusion of machines in land, sea and air [...] propulsion systems [...]..

Learning objectives:

The course aims to deepen the study of propulsion systems for the latest generation of vehicles, for sustainable mobility from an energy and environmental point of view. With reference to propulsion systems for urban and extra-urban vehicular traction, the most recent methodologies available for the reduction of consumption and emissions will be studied in detail. The course will provide an insight into the architectures of propulsion systems, also in relation to the relative degree of hybridization. The operating principle of each sub-component of the propulsion system will be described (battery, electric machines, internal combustion engine, fuel cell, gearbox, etc.). The course will highlight the complex interactions between the various subsystems that make up a modern propulsion system, in order to achieve specific objectives in terms of performance and fuel and/or electricity consumption. The guidelines for the identification of energy flow control strategies in hybrid propulsion systems (series, parallel and their various combinations) will be defined. The theoretical notions about the control and energy management of the propulsion system will be tested through the use of calculation codes. Supplementary seminars are held by personnel of leading companies in the sector, or research centres.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral

Course:	Teaching Language:
Numerical and Experimental Methods for Aircraft Design	English

SSD (Subject Areas):	CREDITS:
ING-IND/03	9

Course year:II	Type of Educational Activity:B

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the aeromechanical project, the flight mission, the flight qualities of vehicles operating in the atmosphere and in space. These issues play a fundamental role in characterizing the safety and management of an aerospace vehicle and its mission. The competences of the sector concern the preliminary project, the performances, the stability, the control of the aforesaid class of vehicles. The analysis and verification methodologies, conducted through modelling, simulation and experimentation (in this case in the wind tunnel), play a strongly unifying and qualifying role in the ambit of the aforementioned topics.

Learning objectives:

The course has the objective to show the numerical and experimental procedures for an accurate analysis of aircraft aerodynamics, stability and control and to provide information on aircraft MDA(Multi-Disciplinary-Analysis)/MDO(Multi-Disciplinary-Optimization) frameworks. The numerical section provides details on the application of software tools for aircraft aerodynamic analysis, load estimations and aircraft stability and control. The second part will deal with the detailed presentation of multi-disciplinary frameworks for aircraft MDA/MDO. The third part will cover experimental section and will present the procedures and the typical issues of aircraft wind tunnel testing. The course will provide about 10-16 hours of laboratory activities in the department main subsonic, closed-circuit, closed test-section wind tunnel.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test. Discussion of a design project.

Course: **Aircraft On-Board Systems**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/05	**CREDITS:** 6
Course year: II	**Type of Educational Activity: B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies aeronautical systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and on-board systems of aeronautical and space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, power generation and distribution, avionics and on-board electronic systems, data transmission and processing information, thermal and air conditioning control, etc.) and the ground systems necessary for mission control and experimentation. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; ground and flight testing of aeronautical systems; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation necessary for trajectory surveying and data acquisition and transmission; the methodologies, subsystems and instrumentation needed for special applications. The sector makes use of specific investigation methodologies, such as simulation for experimental, analytical and numerical modelling	
Learning objectives: The course discusses all aircraft on-board systems that are needed to develop a professional aircraft. Principle of operation and application examples will be presented. All development phases will be considered, such as design, manufacturing, integration, and maintenance.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written and oral test.	

Course:	Teaching Language:
Computational Fluid Dynamics	Italian

SSD (Subject Areas):	CREDITS:
ING-IND/06	9

Course year: I	Type of Educational Activity: B

Teaching Methods:

In person

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the motion of fluids and its applications in engineering. Starting from the continuum fluid balance equations, it includes constitutive relations for Newtonian fluids, dynamics of vorticity and potential flows, compressible and non-compressible flow fields, mass and energy transport phenomena, boundary layers, wakes and jets, acoustic waves and shock, stability and transition, turbulence dynamics, passive scalars and multiphase flows. The relevant topics are completed by theoretical methodologies and numerical simulation and experimental investigation techniques. Essential parts are aerodynamic, gas-dynamic and hydro-dynamic design with applications concerning transport systems, heat transfer and combustion processes, aeroacoustics, transition and turbulence control

Learning objectives:

The course aims to provide the student with the theoretical and practical tools for solving fluid dynamics equations on the computer, illustrating the fundamentals of Computational Fluid Dynamics (CFD) which rely on a knowledge base of linear algebra, numerical methods and mechanics of fluids. The problems of the numerical simulation of the incompressible Navier Stokes equations, in different configurations and with different models, and of the compressible Euler equations in the presence of shock waves will be dealt with. The student will be led to the production of calculation codes for the simulation of classic fluid dynamics problems and will acquire the tools that will allow him to evaluate the potential and limits of the commercial codes used in Computational Fluid Dynamics, in order to allow him to use them consciously and to respond to the demand for work in this sector.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test.

Course: **Turbulence**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/06	**CREDITS:** 6
Course year: II	**Type of Educational Activity: B**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector studies the motion of fluids and its applications in engineering, the dynamics of vorticity, potential and viscous flow fields, compressible and non-compressible flow fields, the interaction between fluid streams and rigid bodies [...], mass and energy transport phenomena, boundary layers, turbulence. The peculiar and multiple numerical simulation techniques complete the fundamental topics of the sector [..].	
Learning objectives: After having introduced the most basic problems of turbulent flows and the corresponding simplified models for internal and external flows, lead the students, through appropriate theoretical insights, to the understanding and conscious use of the most recent theoretical and simulation models.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: oral test.	

Course: Space Mission Design	**Teaching Language:** English
SSD (Subject Areas): ING-IND/05	**CREDITS:** 9
Course year:II	**Type of Educational Activity:B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies aeronautical and space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and on-board systems of aeronautical and space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, power generation and distribution, avionics and on-board electronic systems, data transmission and processing information, thermal and air conditioning control, etc.) and the ground systems necessary for mission control and experimentation. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; the guidance, navigation and control system; the subsystems and ground instrumentation needed to survey the trajectories and orbits and to acquire and transmit data; the methodologies, subsystems and instrumentation needed for special applications, such as remote sensing.

Learning objectives:

This course will provide students with the competences needed to perform the preliminary design of a space mission starting from assigned broad mission objectives. The aim is the preliminary design/selection of the main elements of the space mission architecture (e.g. space, launch and ground segment), and of the satellite (bus and payload) performing the assigned mission. To this end, the technological solutions and sizing procedures typical of space mission elements and satellite sub-systems are taken as reference, and the impact of different solutions and alternatives at system and sub-system level are evaluated. The course aims to familiarize students with the distinctive teamwork of space systems projects, with the organization in phases of the projects and with relevant concepts, such as: project review, critical path analysis, concurrent engineering, reliability and risk analysis, cost analysis, market analysis, design trade-off, etc.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test.

Course: SPACE FLIGHT DYNAMICS	**Teaching Language:** English
SSD (Subject Areas): ING-IND/05	**CREDITS:** 9
Course year:I	**Type of Educational Activity:B**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies space systems as a whole and in the aspects of interaction and integration of the subsystems making up the configuration, in relation to the achievement of mission objectives. The sector also studies individual subsystems and systems on board space vehicles capable of ensuring the operational life of the system (vehicle guidance and control, etc.) and the ground systems necessary for mission control and experimentation. The following aspects of the study are: the definition of the functional architecture of the individual units and the project; the identification of the components in functional terms; the influence on the system and subsystems of the external environment and dynamic interactions; ground and flight testing of space systems; on-board instrumentation; the guidance, navigation and control system; the subsystems and ground instrumentation needed to survey trajectories and orbits and to acquire and transmit data. The sector makes use of specific investigation methodologies, such as simulation for experimental, analytical and numerical modelling

Learning objectives:

The course is aimed at introducing the methods of space flight dynamics that are applied to real space systems. Starting from the basic knowledge linked to two-body mechanics, several topics will be covered in depth, including orbit perturbations analysis and propagation methods, orbital maneuvers, orbit maintenance approaches, and interplanetary trajectories. Special emphasis will also be given to the study of relative dynamics in space and its application to distributed space systems, and to autonomous rendezvous and docking in missions such as on orbit servicing and active debris removal

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and Oral test.

Course:	Teaching Language:
Geometrical Modelling and Virtual Prototyping for Aerospace Applications	Italian

SSD (Subject Areas):	CREDITS:
ING-IND/15	9

Course year:I-II	Type of Educational Activity: D

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the set of methods and tools suitable for producing a technically valid project, in the field of industrial engineering. The concepts governing the use of information technology in industrial design are studied. The morphological, functional and aesthetic study of constructive solutions is accompanied by the development of methods of representation, which also concern the simulation of operation and virtual prototypes. The foundations and methods of design and the related representation, modeling and simulation tools are treated with reference to the aerospace industrial sector. The conception of the overall architecture then involves the decomposition into components for manufacturing, down to the detail of the construction elements and the choice of tolerances, in relation to the cost and operating requirements.

Learning objectives:

Study and use of the most advanced methodologies for design, modeling and management of complex systems of aeronautical and aerospace interest using 3D CAD software. Ability to import information and manage mathematics in the CAD environment and export models useful for FEM and multi-physics analyses. Ability to interpret complex drawings and analyze design problems using an interdisciplinary approach. Resolution of geometric dimensioning problems and drafting of the related project documentation according to ISO-GPS and ASME-GD&T.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test, solution of a graphic test; discussion of the CAD exercises carried out during the course.

Course: **Statistical Lab for Industrial Data Analysis**	**Teaching Language:** English
SSD (Subject Areas): SECS-S/02	**CREDITS:** 9
Course year: I-II	**Type of Educational Activity: D**
Teaching Methods: **In person**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The sector is characterized by a specific attention to modern statistical problems arising in the field of experimental sciences (statistics and probability calculation, design and analysis of experiments) and in particular of engineering (reliability, statistical quality control) and biomedical sciences (anthropometrics, biometrics, medical statistics). The main fields of application concern technology, safety, the environment, the territory, production processes, products, natural resources.	
Learning objectives: Statistical Lab for Industrial Data Analysis is a problem-based learning course whose aim is to train students on the application (illustrated through open source statistical software environment R) of interpretable statistical tecniques for decision-making, possibly scalable also up to big data frameworks. Every student must choose a data analysis project gathered along the course by experts in industrial engineering fields and develop it by working in team. The industrial engineering experts may want to take part to initial, intermediate and final workshops, where student groups shall show their project work in progress. In this way, students will have the opportunity to improve the ability of recognizing and implementing the most suitable statistical techniques to the problem at hand as well as of communicating relevant results and impact of their analysis also to non-statisticians.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written and oral test.	

Course:	Teaching Language:
Machine Learning and Big data	English

SSD (Subject Areas):	CREDITS:
ING-INF/05	9

Course year:I-II	Type of Educational Activity: D

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector is characterized by the set of scientific fields and scientific-disciplinary skills related to the design and implementation of information processing systems, as well as their management and use in the various application contexts with methodologies and techniques typical of engineering. This area includes the theoretical foundations, methods and technologies suitable for producing technically valid projects, from the point of view of both the adequacy of the proposed solutions, and the possibility of technical realization, and economic convenience, and organizational effectiveness. These foundations, methods and technologies range over all aspects relating to a processing system, from hardware to software, from operating systems to computer networks, from databases to information systems, from programming languages, to software, from human-machine interaction to signal and image recognition, multimedia processing, knowledge engineering, artificial intelligence and robotics.

Learning objectives:

The aim of the course is to present the main machine learning techniques, covering all aspects from data preparation to performance evaluation, through practical exercises carried out with commercial and/or open source tools. An introduction to Big Data and Data Analytics lifecycle is also provided, with reference to the design of large and complex databases, and to the process of modeling, acquiring, sharing, analyzing and visualizing the information embedded into Big Data.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test.

Course: **Radar Systems**	**Teaching Language:** Italian	
SSD (Subject Areas): ING-INF/03		**CREDITS:** 9
Course year: I-II	**Type of Educational Activity: D**	
Teaching Methods: **In person.**		
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: design, construction (hardware and software) and operation of equipment, systems and infrastructures for remote sensing applications for the location/identification of stationary/moving objects in air/sea/land traffic control and environmental monitoring.		
Learning objectives: Acquire the operating principles of the various radar systems. Know how to size a radar system and know how to analyze performance. Know the main radar signal processing techniques both in the time domain and in the Doppler one.		
Pre-requisites: None **Is a pre-requisite for:** None		
Types of examinations and other tests: Oral test.		

Course:	Teaching Language:
Design Principles for Wind and Ocean renewable Energy Systems	Italian

SSD (Subject Areas):	CREDITS:
ING-IND/03	6

Course year: I-II	Type of Educational Activity: D

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The course has an interdisciplinary nature and is positioned within the A09/A1 sector, addressing students of the Master's Degree (I or II year) in Aerospace, Mechanical and Naval Engineering and its contents are 'self-sufficient', that is, they do not require particular specific skills to be able to learn the various topics except obviously the basic preparation offered by the respective three-year degrees.

Learning objectives:

The course intends to provide students with all the elements to understand the complete functioning of a system dedicated to the production of renewable energy from the wind and the sea. The course illustrates: methods for quantifying the energy available in primary sources (wind, tidal currents and waves); the principles of energy conversion from the primary source to electricity; the principles of design or choice of the various elements that make up the processing chain; the control principles to limit the maximum power; the existing regulations for determining loads; the methods for evaluating the costs of the complete system and the energy produced; application examples of systems for the generation of renewable energy from: onshore and offshore wind, tidal currents and waves.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test. Discussion of a design project.

Course: **Electro-magnetic Fundamentals for Space Applications**	**Teaching Language:** Italian
SSD (Subject Areas): ING-INF/02	**CREDITS:** 9
Course year:I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector is interested in scientific and didactic-training activities relating to electromagnetic fields, drawing its historical origin from Maxwell's equations. The sector studies the theoretical, experimental, numerical and applicative aspects relating to electromagnetic fields and, in particular, to radiofrequency, microwaves, millimeter waves, TeraHertz and optics; electrical, electronic, optical and photonic components, circuits and systems, where electromagnetic aspects are relevant. In the field of information and telecommunications engineering, the founding studies concern free and guided propagation and methods of design and characterization of circuits and antennas, together with the analysis of electrodynamics, radiation and diffraction problems. Propagation studies are directed towards the characterization of the transmission channel for fixed and mobile communications and optical components and systems, also for the purpose of planning and implementing services. The design of passive and active circuits and very high frequency antennas requires the study of very complex situations, constituting the scope of microwave and millimeter wave components and circuits and systems. Similar considerations apply to optical and photonic circuits and technologies [...]

Learning objectives:

The student will acquire the knowledge of electromagnetism necessary to study its applications, with particular reference to the aerospace ones. The course will be accompanied by numerical/experimental laboratory exercises through the use of measurement instruments and commercial design software.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Oral test.

Course: **Impact Dynamics**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/04	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity: D**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The teaching contents take up those of the sector declaration ING-IND/04 with particular reference to the technological, structural and constructive skills related to atmospheric and space vehicles, such as fixed-wing aircraft, rotary-wing aircraft, launchers , satellites, space stations, to name a few. In detail, the teaching covers the skills concerning the study of non-linear static and dynamic structural phenomena up to impact phenomena. Finally, reflections on the problems of the behavior of metallic and composite materials under impact conditions, certification and the tests necessary to achieve it are initiated.	
Learning objectives: The course aims to provide an in-depth description of all aspects related to the design of vehicles with respect to their crashworthiness. Here within are included technical aspects, which are finally placed in the context of the total product development processes of current industries. This course introduces students to different computational techniques used for modelling engineering problems in solids and structures. To this end, in addition to lectures, the course includes practical classes in the computer laboratory where the methodologies and tools illustrated in class are applied, together with some example of experimental laboratory tests.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written and oral test.	

Course: **Elastodynamics and Structural Health Monitoring Principles**	**Teaching Language:** English
SSD (Subject Areas): ING-IND/04	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity: D**
Teaching Methods: **In person.**	
Contents extracted from the SSD declaratory list consistent with the learning objectives of the course: The teaching contents take up those of the declaration of the SSD ING-IND/04, with particular reference to the study of the propagation of elastic waves in isotropic and anisotropic materials. The course also deals with safety and maintenance issues in the aeronautical and space fields.	
Learning objectives: Elasto-dynamics equations for simple structural items made out of isotropic and anisotropic materials. Dispersion curves for simple structural configurations. Waves parameters (Time of Flight, transmission factor, ect..) from numerical and/or experimental waves propagations signals by signal analysis techniques (Short time Fourier Transform, Hilbert Transform, statistical methodologies, etc.). Finite elements models for wave propagation simulation into typical aerospace structural configurations. State-of-the-art ultrasonic Non-Destructive-Techniques (C-Scan) for structural health analysis in composites structure.	
Pre-requisites: None **Is a pre-requisite for:** None	
Types of examinations and other tests: Written test.	

Course: **Electrical Basis for Aeronautics**	**Teaching Language:** Italian
SSD (Subject Areas): ING-IND/32	**CREDITS:** 6
Course year: I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the problems concerning electric machines, electric sensors and actuators, electronic power components and converters, electric drives, electric and electronic technologies and electric industrial applications, and which translate basic and applicative problems of energy conversion in order to make it available in the shape, size and quality necessary for the various applications in industry and transport.

Learning objectives:

The course intends to provide the basic notions and appropriate insights on electrical and electronic systems with particular reference to those of power on board aircraft and other aeronautical systems. These include alternators, static power converters, on-board electrical energy storage, distribution and utilization systems, also with reference to switching and protection devices, and electromechanical actuators. The main architectures envisaged for the electric and hybrid propulsion of aircraft are also described. A part of the course is dedicated to cover the contents of modules 4 and 5 of the regulatory program (EASA Part 66/ EMAR 66), for the benefit of those wishing to pursue a career in the aircraft maintenance sector and achieve an Aircraft Maintenance License (LMA)/Military Aircraft Maintenance License (MAML).

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test.

Course: **Signal and Image Processing**	**Teaching Language:** Italian
SSD (Subject Areas): ING-INF/03	**CREDITS:** 9
Course year: I-II	**Type of Educational Activity: D**

Teaching Methods:

In person.

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the planning, design, construction (hardware and software) and operation of equipment, systems and infrastructures for applications aimed at transferring signals via cable (copper or fiber), via radio (terrestrial or satellite) or other means of propagation, with the use of specific technologies such as optical and mobile communications; to the treatment of mono/multidimensional signals for the purpose of filtering, redundancy reduction, synthesis, extraction of information elements; the recognition of shapes for the semantic interpretation of the information content of signals and images; to network interconnection for the transport of information and for the use of interactive/distributive services, in the context of applications such as telematics; to remote sensing for the location/identification of stationary/moving objects in air/sea/land traffic control and environmental monitoring. Basic aspects are included (theory of random phenomena, of information, of codes, of signals, of traffic, of protocols, etc.) and system/technological skills indispensable to a professional figure who has the technical and organizational skills to solve in cost-effective way the problems of relevance and contribute to the scientific-technological evolution of the sector.

Learning objectives:

Acquire the basic conceptual and mathematical tools for processing digital images and video sequences. Knowing how to apply these concepts to the development of algorithms for processing multimedia signals.

Pre-requisites:

None

Is a pre-requisite for:

None

Types of examinations and other tests:

Written and oral test.

Course: AIRCRAFT OPERATIONS	**Teaching Language:** English
SSD (Subject Areas): ING-IND/03	**Credits:** 6
Course Year: I-II	**Type of Educational Activity: D**
Teaching Methods: in person	

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the aeromechanical project, the flight mission, the flight qualities of vehicles operating in the atmospheric environment. These issues play a fundamental role in characterizing the safety and management of an aerospace vehicle and its mission. The competences of the sector concern the preliminary design, the performances, the stability, of the aforesaid class of vehicles. The methodologies of analysis and verification, conducted through modelling and simulation, play a strongly unifying and qualifying role in the ambit of the aforementioned topics.

Learning objectives:

The course will focus on aircraft operations, giving a better understanding of the organization of a flight operations department, management systems and human factors application as it relates to organizational structure inside operations department at an Airline Operations Centre.

The key topics that are covered during this course include: Regulatory framework and IOSA, flight operations department and it's environment, flight and route planning, operation and direct and indirect operative costs, ground performance and operations, some maintenance considerations, life-cycle costs and environmental issues and environmental impact (including pollution and airport noise measurement), sustainability and safety (Safety Management System). Some additional topic will deal with flight accident and human factors in flight operations.

Propedeuticità in ingresso:

None

Propedeuticità in uscita:

None

Tipologia degli esami e delle altre prove di verifica del profitto:

Oral examination

Course: Launch and Re-entry Vehicle Design and Dynamics	**Teaching Language:** English
SSD (Subject Areas): ING-IND/03	**Credits:** 6
Course Year: I-II	**Type of Educational Activity: D**
Teaching Methods: in person	

Contents extracted from the SSD declaratory list consistent with the learning objectives of the course:

The sector studies the aeromechanical project, the flight mission, the flight qualities of vehicles operating in the atmospheric environment. These issues play a fundamental role in characterizing the safety and management of an aerospace vehicle and its mission. The competences of the sector concern the preliminary design, the performances, the stability, of the aforesaid class of vehicles. The methodologies of analysis and verification, conducted through modelling and simulation, play a strongly unifying and qualifying role in the ambit of the aforementioned topics.

Learning objectives:

The course gives an overview of launch and re-entry vehicle design, with focus on their performance and flight dynamics. After a brief introduction which will highlight the need of this new class of vehicles for new missions and use (like the virgin galactic commercial space flight) the course will give to the students all the main relevant steps to deal with the design of such vehicles and the calculation of their performance. One of the first step will be to make an analysis of the mission requirements and hypersonic flight corridor. The design process for this vehicles will be presented and discussed, with some example of application.

After some brief notes on the aeromechanical design, the analysis of the propulsive requirements and the evaluation of flight performance of hypersonic vehicle will be presented.

The last part will deal with launch and re-entry vehicles flight dynamics and control, with the ability of following some assigned re-entry flight path.

Propedeuticità in ingresso:

None

Propedeuticità in uscita:

None

Tipologia degli esami e delle altre prove di verifica del profitto:

Oral examination

ANNEX 2.2

DEGREE PROGRAM DIDACTIC REGULATIONS

AEROSPACE ENGINEERING

CLASS LM-20

School: Polytechnic and Basic Sciences School

Department: Industrial Engineering

Didactic Regulations in force since the academic year 2024-2025

<table>
<tr><td colspan="2">Training Activity:
under Art. 10, c. 5, letter d</td><td colspan="2">Training Activity Language:
Italian, English or other UE language</td></tr>
<tr><td colspan="2">Content of the activities consistent with the training objectives of the course:
Additional language skills
training and orientation periods
IT and telematics skills
Other knowledge useful for job placement</td><td colspan="2">CFU:
0-6
0-3
0-12
0-3</td></tr>
<tr><td colspan="3">Course year: II</td><td>Type of Training Activity: F</td></tr>
<tr><td colspan="4">Teaching Methods:
in-person</td></tr>
<tr><td colspan="4">Objectives:
These activities contribute to the achievement of linguistic, computer-based and/or vocational training objectives for the world of work</td></tr>
<tr><td colspan="4">Propaedeuticities:
none

Is a propaedeuticity for:
none</td></tr>
<tr><td colspan="4">Types of examinations and other tests:
aptitude</td></tr>
</table>

ALLEGATO 3 – CRITERIA FOR ACCESS TO THE DOUBLE DEGREE AND PERIOD OF ABROAD EDUCATIONAL ACTIVITIES

Under the terms established by an cooperation agreement signed between Università degli Studi di Napoli(UNINA)and the Escuela Tecnica Superior de Ingegneria of the University of Seville (US), students enrolled in the Corso di Laurea Magistrale in Ingegneria Ingegneria Aerospaziale are allowed to obtain a Double Degree, namely Laurea Magistrale in Ingegneria Aerospaziale, awarded by the University of Naples Federico II, and Máster en Ingeniería Aeronáutica, awarded by the Escuela Tecnica Superior de Ingegneria of the University of Seville (Spain).

The double degree program has a duration of 2 years and 1 semester. The student completes the first year at the home university obtaining 60 CFUs and then continues for the next period of 1 year and 1 semester at the host university obtaining additional 120 CFUs.

For the student who completes the first year at UNINA, admission to the double degree program is through a selection according to criteria indicated in the relevant call for applications. The call for applications is annual and is reserved for students enrolled in the first year of the Corso di Laurea Magistrale in Ingegneria Ingegneria Aerospaziale. The call reports the total number of students admitted to the double degree program for the relevant academic year. Admitted students are requested to choose one among the three available study plans as detailed in Appendix 4.

For the student who completes the first year at US, it will be US's discretion to determine how students are selected. The selected student who completes the first year at US is requested to choose one among the three available study plans as detailed in Annex 4. Based on this choice, the student is admitted by a dedicated resolution of the Degree Course to the second year of the Corso di Laurea Magistrale in Ingegneria Ingegneria Aerospaziale at UNINA with a personalized study plan as detailed in Attachment 4.

ALLEGATO 4 – TABLE OF CORRESPONDENCE OF TEACHING ACTIVITIES

The following correspondences are established , for the achievement of the double degree between the teaching activities carried out at Corso di Laurea Magistrale in Ingegneria Ingegneria Aerospaziale, Università degli Studi di Napoli Federico II and the teaching activities carried out at the Máster en Ingeniería Aeronáutica of the Escuela Tecnica Superior de Ingegneria of the University of Seville, Spain. The CdS reserves the right to evaluate, in agreement with the Escuela Tecnica Superior, any variations with respect to the tables and/or personalized study plans

Training activity carried out at CdS in Aerospace Engineering	ECTS	**Training activity carried out at Escuela Tecnica Superior de Ingegneria dell'università di Siviglia**	ECTS
Meccanica Applicata all'Ingegneria Aerospaziale (Mechanics applied to Aerospace Engineering)	9	Complementos de Mecánica Racional	5
		Complementos de Mecánica de Sólidos	5
Dinamica e Simulazione di Volo (Flight Dynamics and simulation)	9	Mecánica del vuelo avanzada	5
		Sistemas de control en aeronaves	5
Strutture Aerospaziali Avanzate (Aerospace Advanced Structures)	9	Diseño estructural de aeronaves	5
		Complementos de Estructuras Aeronáuticas	5
Economia e Organizzazione del Settore Aerospaziale (Economy and organization of aerospace Industry)	6	Producción Aeroespacial	5
Aerodinamica dei Velivoli (Aircraft Aerodynamics)	9	Mecánica de Fluidos y aerodinámica avanzadas	4
		Complementos de Mecánica de Fluidos y Aerodinámica	5
Space Propulsion	9	Complementos de Propulsión	5
		Propulsión de vehículos Espaciales	4
Space Flight Dynamics	9	Dinámica de Vehículos Espaciales	5
		Complementos de Mecánica Orbital	4
Air Traffic Management and Control	9	Organización Aeronáutica y Transporte Aéreo	5
		Navegación aérea y Gestión del tráfico aéreo	5
Aeroelasticity	6	Aeroelasticidad	5
Costruzioni Aerospaziali II (Aerospace Constructions II)	9	Mecánica de Materiales Compuestos	5
		Uniones en Estructuras Aeronáuticas	5

Strutture Spaziali (Space Structures)	9	Complementos de Estructuras	5
		Complementos de Estructuras Aeronáuticas	5
Aviónica Avanzada	5	Aircraft Onboard Systems	6
Helicopteros	5	Aerodinamica dell'ala rotante (Rotary Wing Aerodynamics)	6
Robótica aeroespacial	5	Spacecraft dynamics and control	6

The student who participates in the program can choose one among 3 available study plans: aeronautics, propulsion/fluid dynamics, and space.
For the student who completes the first year of study at the University of Naples Federico II, the study plan shall follow one among the following three tables depending on the chosen curriculum (CV).

AERONAUTICAL CV								
1st year UNINA	1st semester	Meccanica Applicata all'Ingegneria Aerospaziale (Mechanics applied to Aerospace Engineering) (9 ECTS)			Dinamica e Simulazione di Volo (Flight Dynamics and Simulation) (9 ECTS) Strutture Aerospaziali Avanzate (Advanced Aerospace Structures) (9 ECTS)			
	2st semester	Economia e Organizzazione del Settore Aerospaziale (Economy and organization of aerospace Industry) (6 ECTS)			Aerodinamica dei Velivoli (Aircraft Aerodynamics) (9 ECTS) Avionica (Avionics) (9 ECTS)			
	Autonomous choise (9CFU)							
2st year US	1st Semester	Complementos de transporte aéreo (5 ECTS)	Aviónica Avanzada (5 ECTS)	Procesos de fabricación Aeronáutica (4 ECTS)	Dinámica de Vehículos Espaciales (4 ECTS)	Diseño de Motores a Reacción (4 ECTS)	Propulsión de vehículos Espaciales (4 ECTS)	Diseño mecánico de componentes y sistemas (5 ECTS)
	2st semester	Aeroelasticidad (5 ECTS)	Mecánica de Materiales Compuestos (5 ECTS)	Organización Aeronáutica y Transporte Aéreo (5 ECTS)	Navegación aérea y Gestión del tráfico aéreo (5 ECTS)	Uniones en Estructuras Aeronáuticas (5 ECTS)	Autonomous Choice (5 ECTS)	
3st year US	1st Semester	Diseño de turbomáquinas y transferencia de calor (5 ECTS)		Trabajo fin de master (12 ECTS)		Proyecto y Certificación de Aeropuertos (5 ECTS)	Tráfico Aéreo Avanzado (5 ECTS)	

<table>
<tr><th colspan="8">FLUID DYNAMICS/PROPULSION CV</th></tr>
<tr><td rowspan="3">1st year UNINA</td><td>1st Semester</td><td colspan="3">Meccanica Applicata all'Ingegneria Aerospaziale
(Mechanics applied to Aerospace Engineering)
(9 ECTS)</td><td colspan="3">Hypersonic Aerodynamics
(9 ECTS)
Fluidodinamica Numerica
(Computational Fluid Dynamics)
(9 ECTS)
Fluidodinamica Sperimentale
(Experimental Fluid Dynamics)
(9 ECTS)</td></tr>
<tr><td>1st Semester</td><td colspan="3">Economia e Organizzazione del Settore Aerospaziale
(Economy and organization of aerospace Industry)
(6 ECTS)</td><td colspan="3">Aerodinamica dei Velivoli
(Aircraft Aerodynamics)
(9 ECTS)</td></tr>
<tr><td colspan="7">Autonomous choise (9CFU)</td></tr>
<tr><td rowspan="2">2st year US</td><td>1st Semester</td><td>"Cálculo de aeronaves y sistemas de aeronaves"
(5 ECTS)</td><td>Aviónica Avanzada
(5 ECTS)</td><td>Procesos de fabricación Aeronáutica
(4 ECTS)</td><td>Dinámica de Vehículos Espaciales
(4 ECTS)</td><td>Diseño de Motores a Reacción
(4 ECTS)</td><td>Diseño mecánico de componentes y sistemas
(5 ECTS)</td></tr>
<tr><td>2st semester</td><td>Aeroelasticidad
(5 ECTS)</td><td>Mecánica de Materiales Compuestos
(5 ECTS)</td><td>Organización Aeronáutica y Transporte Aéreo
(5 ECTS)</td><td>Complementos de Propulsión
(5 ECTS)</td><td>Propulsión de vehículos Espaciales (4 ECTS)</td><td>Helicopteros (5 ECTS)</td></tr>
<tr><td>3st year US</td><td>1st Semester</td><td>Diseño de turbomáquinas y transferencia de calor
(5 ECTS)</td><td>Diseño estructural de aeronaves
(5 ECTS)</td><td colspan="2">Trabajo fin de master
(12 ECTS)</td><td>Proyecto y Certificación de Aeropuertos
(5 ECTS)</td><td>Tráfico Aéreo Avanzado
(5 ECTS)</td></tr>
</table>

<table>
<tr><th colspan="8">SPACE CV</th></tr>
<tr><td rowspan="3">1st year UNINA</td><td>1st Semester</td><td colspan="3">Meccanica Applicata all'Ingegneria Aerospaziale
(Mechanics applied to Aerospace Engineering)
(9 ECTS)</td><td colspan="4">Space Systems
(9 ECTS)
Strutture Spaziali
(Space Structures)
(9 ECTS)
Aerospace Remote Sensing Systems
(9 ECTS)</td></tr>
<tr><td>2st Semester</td><td colspan="3">Space Experiments
(6 ECTS)</td><td colspan="4">Space Mission Desing
(9 ECTS)</td></tr>
<tr><td colspan="8">Autonomous Choice (9CFU)</td></tr>
<tr><td rowspan="2">2nd year US</td><td>1st semester</td><td>Complementos de transporte aéreo
OR
"Cálculo de aeronaves y sistemas de aeronaves"
(5 ECTS)</td><td>Mecánica del vuelo avanzada
(5 ECTS)</td><td>Procesos de fabricación Aeronáutica
(4 ECTS)</td><td>Mecánica de Fluidos y aerodinámica avanzadas
(4 ECTS)</td><td>Diseño de Motores a Reacción
(4 ECTS)</td><td>Diseño mecánico de componentes y sistemas
(5 ECTS)</td></tr>
<tr><td>2nd semester</td><td>Aeroelasticidad
(5 ECTS)</td><td>Mecánica de Materiales Compuestos
(5 ECTS)</td><td>Organización Aeronáutica y Transporte Aéreo
(5 ECTS)</td><td>Autonomous Choice
(5 ECTS)</td><td>Autonomous Choice
(5 ECTS)</td><td colspan="2">Autonomous Choice
(5 ECTS)</td></tr>
<tr><td>3rd year US</td><td>1st semester</td><td>Diseño de turbomáquinas y transferencia de calor
(5 ECTS)</td><td>Aviónica Avanzada
(5 ECTS)</td><td colspan="2">Trabajo fin de master
(12 ECTS)</td><td>Proyecto y Certificación de Aeropuertos
(5 ECTS)</td><td>Tráfico Aéreo Avanzado
(5 ECTS)</td></tr>
</table>

For the student who completes the first year of study at the Escuela Tecnica Superior de Ingegneria dell'University of Seville, the study plan shall follow one among the following three tables depending on the chosen curriculum.

<table>
<tr><th colspan="9">AERONAUTICS CV</th></tr>
<tr><td rowspan="2">1st year US</td><td>1st semester</td><td>Complementos de transporte aéreo
OR
"Cálculo de aeronaves y sistemas de aeronaves"
(5 ECTS)</td><td>Mecánica del vuelo avanzada
(5 ECTS)</td><td>Procesos de fabricación Aeronáutica
(4 ECTS)</td><td>Dinámica de Vehículos Espaciales
(4 ECTS)</td><td>Diseño de Motores a Reacción
(4 ECTS)</td><td>Propulsión de vehículos Espaciales
(4 ECTS)</td><td>Mecánica de Fluidos y aerodinámica avanzadas
(4 ECTS)</td></tr>
<tr><td>2nd semester</td><td>Aeroelasticidad
(5 ECTS)</td><td>Mecánica de Materiales Compuestos
(5 ECTS)</td><td>Organización Aeronáutica y Transporte Aéreo
(5 ECTS)</td><td>Producción Aeroespacial Autonomous choice
(5 ECTS)</td><td colspan="2">Complementos de Mecánica de Fluidos y Aerodinámica Autonomous choice
(5 ECTS)</td><td>Navegación aérea y Gestión del tráfico aéreo Autonomous choice
(5 ECTS)</td></tr>
<tr><td rowspan="3">2nd year UNINA</td><td>1st semester</td><td colspan="2">Meccanica Applicata all'Ingegneria Aerospaziale
(Mechanics applied to Aerospace Engineering)
or
Metodi Matematici per l'Ingegneria
(Mathematical Methods for Engineering)
(9 ECTS)</td><td colspan="2">Dinamica e Simulazione di Volo
(Flight Dynamics and Simulation)
(9 ECTS)</td><td colspan="2">Strutture Aerospaziali Avanzate
(Advanced Aerospace Structures)
(9 ECTS)</td><td>Numerical and experimental methods for Aircraft Design
or
Unmanned Aircraft Systems
(9 ECTS)</td></tr>
<tr><td>2nd semester</td><td colspan="3" rowspan="2">2x6 ECTS
Curriculum autonomous or autonomous choice</td><td colspan="2">Aircraft Design
(9 ECTS)</td><td colspan="3">Avionica
(Avionics)
(9 ECTS)</td></tr>
<tr><td>3rd year UNINA</td><td>1st semester</td><td colspan="2">Traineeship
(12 ECTS)</td><td colspan="3">Thesis
(12 ECTS)</td></tr>
</table>

<table>
<tr><th colspan="9">FLUID DYNAMICS/PROPULSION CV</th></tr>
<tr><td rowspan="2">1st year US</td><td>1st semester</td><td colspan="2">Complementos de transporte aéreo
OR
“Cálculo de aeronaves y sistemas de aeronaves”
(5 ECTS)</td><td>Mecánica del vuelo avanzada
(5 ECTS)</td><td>Procesos de fabricación Aeronáutica (4 ECTS)</td><td>Dinámica de Vehículos Espaciales
(4 ECTS)</td><td>Diseño de Motores a Reacción
(4 ECTS)</td><td>Propulsión de vehículos Espaciales
(4 ECTS)</td><td>Mecánica de Fluidos y aerodinámica avanzadas
(4 ECTS)</td></tr>
<tr><td>2nd semester</td><td colspan="2">Aeroelasticidad
(5 ECTS)</td><td>Mecánica de Materiales Compuestos
(5 ECTS)</td><td>Organización Aeronáutica y Transporte Aéreo
(5 ECTS)</td><td>Producción Aeroespacial
Autonomous choice
(5 ECTS)</td><td colspan="2">Complementos de Mecánica de Fluidos y Aerodinámica
Autonomous choice
(5 ECTS)</td><td>Complementos de Propulsión
Autonomous choice
(5 ECTS)</td></tr>
<tr><td rowspan="3">2nd year UNINA</td><td>1st semester</td><td colspan="3">Meccanica Applicata all’Ingegneria Aerospaziale
(Mechanics applied to Aerospace Engineering)
or
Metodi Matematici per l’Ingegneria
(Mathematical Methods for Engineering)
(9 ECTS)</td><td colspan="3">Fluidodinamica Numerica
(Computational Fluid Dynamics)
(9 ECTS)</td><td>Experimental fluid dynamics
(9 ECTS)</td><td>Hypersonic Aerodynamics
(9 ECTS)</td></tr>
<tr><td>2nd semester</td><td colspan="3" rowspan="2">2x6 ECTS
Curriculum autonomous or autonomous choice</td><td colspan="3">Aerodinamica dei velivoli
(Aircraft Aerodynamics)
(9 ECTS)
or
Space Propulsion
(9 ECTS</td><td colspan="2">Avionica
(Avionics)
(9 ECTS)</td></tr>
<tr><td>3rd year UNINA</td><td>1st semester</td><td colspan="3">Traineeship
(12 ECTS)</td><td colspan="2">Thesis
(12 ECTS)</td></tr>
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<tr><th colspan="9">SPACE CV</th></tr>
<tr><td rowspan="2">1st year US</td><td>1st semester</td><td colspan="2">Complementos de transporte aéreo
OR
“Cálculo de aeronaves y sistemas de aeronaves”
(5 ECTS)</td><td>Mecánica del vuelo avanzada
(5 ECTS)</td><td>Procesos de fabricación Aeronáutica (4 ECTS)</td><td>Dinámica de Vehículos Espaciales
(4 ECTS)</td><td>Diseño de Motores a Reacción
(4 ECTS)</td><td>Propulsión de vehículos Espaciales
(4 ECTS)</td><td>Mecánica de Fluidos y aerodinámica avanzadas
(4 ECTS)</td></tr>
<tr><td>2nd semester</td><td colspan="2">Aeroelasticidad
(5 ECTS)</td><td>Mecánica de Materiales Compuestos
(5 ECTS)</td><td>Organización Aeronáutica y Transporte Aéreo
(5 ECTS)</td><td>Producción Aeroespacial Autonomous choice
(5 ECTS)</td><td colspan="2">Complementos de Mecánica Orbital Autonomous choice
(5 ECTS)</td><td>Complementos de Propulsión Autonomous choice
(5 ECTS)</td></tr>
<tr><td rowspan="3">2nd year UNINA</td><td>1st semester</td><td colspan="3">Meccanica Applicata all’Ingegneria Aerospaziale
(Mechanics applied to Aerospace Engineering)
or
Metodi Matematici per l’Ingegneria
(Mathematical Methods for Engineering)
(9 ECTS)</td><td colspan="2">Space Systems
(9 ECTS)</td><td>Strutture Spaziali
(Space Structures)
(9 ECTS)</td><td colspan="2">Hypersonic Aerodynamics
(9 ECTS)</td></tr>
<tr><td>2nd semester</td><td colspan="3" rowspan="2">2x6 ECTS
Curriculum autonomous or autonomous choice</td><td colspan="5">Space Mission Design
(9 ECTS)</td></tr>
<tr><td>3rd year UNINA</td><td>1st semester</td><td>Aerospace Remote Sensing Systems
(9ECTS)</td><td>Traineeship
(12 ECTS)</td><td colspan="3">Thesis
(12 ECTS)</td></tr>
</table>