Bachelor's degree Aerospace Engineering

Courses	Module/Form	Credits	Language
First Year – I Semester			
Mathematical Analysis I		9	Italian
Geometry and algebra		6	Italian
Industrial technical drawing		6	Italian
English language		3	English
First Year – II Semester			
Mathematical Analysis II		9	Italian
Chemistry		6	Italian
Elements of computer science		6	Italian
General Physics I		9	Italian
Second Year – I Semester			
Mathematical physics		6	Italian
Aerodynamics		9	Italian
Second Year – II Semester			
Aerospace structures		9	Italian
Second Year – Annual			
Gas dynamics	Termo fluid dynamics (1stSemester)	6	Italian
	Gas dynamics (2ndSemester)	6	Italian
Aerospace system	Aerospace system I (1stSemester)	6	Italian
	Aerospace system II (2ndSemester)	6	Italian
Flight mechanics	Performance (1stSemester)	6	Italian
	Stability manoeuvres (2ndSemester)	6	Italian
Third Year – Annual			
Electromagnetism and electrical engineering	General Physics I (1st Semester)	6	Italian
	Electrical engineering (2ndSemester)	6	Italian
Third Year – I Semester			
Aerospace materials technologies		6	Italian
Numerical methods in aerospace engineering		6	Italian
Aerospace construction		9	Italian
Third Year – II Semester			
Aerospace propulsion		9	Italian
Probability and Statistics		6	Italian
Final test		3	Italian/English
Third Year – I and II Semester			
Autonomous choice Courses*		12	Italian/English
Traineeship		3	Italian

(*) Autonomous choice suggested Courses (12 Credits)

I Semester		
Courses	Credits	Language
Aerospace Structures Complements	6	Italian
Structures Calculus Laboratory	6	Italian
Aeronautics Regulations	6	Italian
On-Board-System Laboratory	6	Italian
II Semester		
Courses	Credits	Language
Special Technologies II	6	Italian
Aircraft Maintenance	6	Italian
Structures Experiments	6	Italian

COURSE DETAILS

MATHEMATICAL ANALYSIS I

SSD MAT/05

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR: 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: I
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

………

PREREQUISITES (IF APPLICABLE)

The mathematical content of secondary school programs

LEARNING GOALS

To provide the fundamental concepts, in view of the applications, related to infinitesimal, differential and integral calculus for the real functions of a real variable; make the students acquire adequate logical formalization skills and conscious operational skills.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The students will have to show knowledge of the notions (definitions, statements, proofs if provided by the program) related to infinitesimal, differential and integral calculus for real functions of a real variable and the calculation tools developed, and to be able to understand related topics by elaborating the notions acquired.

Applying knowledge and understanding
The students must demonstrate that he knows how to apply what he has learned in solving verification exercises developed by the teacher, related to topics such as: domains of functions, limits of sequences and functions, numerical series, graph of a function, integral calculus.

COURSE CONTENTS-SYLLABUS

(1 cfu) Numerical sets - Naturals, integers, rationals. The axioms of real numbers. Infimum, supremum, maximum, minimum of a set. Archimedes' principle. Density of Q in R; roots; powers with real exponent. Principle of induction. Bernoulli's inequality. Binomial formula.

(1 cfu) Elementary functions.

(1.5 cfu) Sequences - Limit of a sequence; first properties of limits: uniqueness of the limit, comparison theorem, sign permanence. Operations with limits and indeterminate forms. Monotone sequences: regularity theorem; the number "e". Ratio criterion. N-th Root criterion. Arithmetic mean and geometric mean. Ratio-root criterion. Cauchy convergence criterion. Subsequences. Bolzano-Weierstrass theorem.

(1 cfu) Numerical series - Definitions and first properties; operations with series. Geometric series, harmonic series and generalized harmonic series. Cauchy criterion for series. Series with non-negative terms: root, ratio, comparison, asymptotic comparison criteria. Euler-Mascheroni constant. Series with alternating signs: Leibniz criterion; estimate of the reminder. Absolutely converging series and their properties.

(1 cfu) Functions - Topology of the real line: cluster points, closed, open, compact sets. Limits of functions and their properties. Equivalent definition of limit. Operations with limits and indeterminate forms.

Monotone functions: regularity theorems; continuous functions; Lipschitz functions; inverse functions; composite functions. Maxima and minima: Weierstrass theorem. Zero value theorem, theorem of intermediate values. Uniformly continuous functions, Cantor's theorem.

(2 cfu) Differential calculus - Definition of derivative and its geometric meaning. Rules of derivation; derivatives of elementary functions. Relative extremes: necessary condition of the first order. Rolle and Lagrange theorems; characterization of monotone functions in intervals. Relative extremes: sufficient conditions of the first order. Theorem of extension of the derivative. First theorem of de L'Hôpital; second theorem of de L'Hôpital; calculation of limits that occur in an indeterminate form. Infinitesimal and infinite: principles of cancellation. Taylor's formula with remainder in the form of Peano. Taylor's formula with remainder in Lagrange form. Outline of Taylor series. Relative maxima and minima: necessary conditions and sufficient conditions of the second order. Geometric meaning of the second derivative. Convexity and concavity in an interval; characterization of convex functions in intervals; inflected; asymptotes; graphs of functions.

(1,5 cfu) Integral calculus - Outline of measure according to Peano-Jordan. Riemann integral of a bounded function in a compact interval. Area of the trapezoid. Integrability of monotone functions in compact intervals. Integrability of continuous functions in compact intervals. Properties of the definite integral. Integral mean theorem. Fundamental theorem of integral calculus. Primitives and indefinite integration. Indefinite integration rules: sum decomposition, integration by parts, integration by substitution, integration of rational functions. Generalization of the concept of integral: summability. Summability criteria.

READINGS/BIBLIOGRAPHY

Main Textbook

SEE THE TEACHER'S WEBSITE

TEACHING METHODS

The lessons will be face to face, and about one third of the lessons will be of exercises.

EXAMINATION/ EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
Other	

In case of a written exam, questions refer to:	**Multiple choice answers**	X
	Open answers	X
	Numerical exercises	X

b) Evaluation criteria:

The grade is formulated by the Examination Commission based on the outcome of written test, in particular on the basis of the consistency and accuracy of the exercises performed and the adequacy of the answers provided by the student to the theory questions. The final grade is also suitably motivated to the student.

COURSE DETAILS

INDUSTRIAL TECHNICAL DRAWING

SSD ING-IND/15

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR: 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")
NONE

LEARNING GOALS

The Course deals with graphic representation techniques of machine components with a special focus on Monge's method of projections. Furthermore, the Course aims to introduce the students to the basic engineering language as well as to the ability of shape imagination and visualization in the space. Starting from the knowledge of the basic shapes for machine components, the students acquire the ability to interpret the construction drawing of the main machine components and their assemblies. Thus, the Course allows the student to know the machine elements, to make a dimensioned drawing, to correctly read and interpret basic industrial drawings according to the international standards, in conjunction with a critical analysis of shapes and functions of the main machine elements.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate that he/she has achieved an adequate knowledge of industrial technical drawing with a special emphasis on the following features:

- Knowledge of technical drawing as graphic language for the communication of technical information at the international level;
- Knowledge of the basic methods of freehand drawing or computer-aided design (CAD) systems
- Basic knowledge of functional analysis of mechanical assemblies;
- To distinguish the geometric characteristics of the product and their relationship with simple processing cycles employed for the product development;
- Definition of functioning/operating principles, construction aspects and performance requirements of the basic mechanical components;

Applying knowledge and understanding

At the end of the Course the student must demonstrate that he/she has acquired notions of industrial technical drawing and, in particular, the following abilities:

- Interpretation of part and assembly drawings, and representation of simple machines;
- Knowledge and planning of tolerance of mechanical system components;
- Understanding of the effect of the manufacturing errors on the functional characteristics of a mechanical assembly and of the surface finishing on the mechanical strength of metallic materials;
- Development of assemblies of simple groups and construction drawings, according to the fabrication methodologies;
- Correct use of unified elements;
- Understanding of design and verification methodologies and technical reference standards;

COURSE CONTENT/SYLLABUS

[2 CFU] The first part of the Course consists of elements of descriptive geometry and introduces the students to the technical standards and regulation (UNI, ISO) concerning orthogonal projections, sections and dimensioning systems.

Function and role of technical drawing. Projective and descriptive geometry: Monge's projections and selection of principal views. The surface intersection problem: a brief outline. Standardisation criteria and standards for technical drawing. Normal number series.
Standardised systems for the representation of sections of solids. Projected sections – parallel planes and incident planes, partial sections, revolved sections. Half-views and half-sections. Conventional indications for cutting plane line. Common errors in the representation of sections.
Standardised systems for graphic representations and dimensioning systems for solids. Geometric dimensioning: size and location dimensions. Assembly dimensions and auxiliary dimensions. Dimensioning systems (functional, technological and for inspection). Functional conditions for assembly: axial constraints, radial constraints, accessibility, assemblability and disassemblability of parts. Selection of dimensions according to functional conditions. Technological dimensioning according to machining, casting and moulding technologies. Mechanical behaviour of materials: elastic and plastic behaviour. Yield strength, proportional limit and ultimate strength. Selection of processing dimensions according to the processing cycle for axisymmetric elements. Threads: conventional representation and technological dimensions. Representation and dimensioning of chamfers, rounds, conicity, tapering, inclined surfaces, grooves for internal and external threads. Standardisation and unification.

[2 CFU] The second part of the Course deals with surface finishing and dimensional tolerances. Accordingly, this part aims to introduce the students to the main functional and construction problems generally present in the assemblies as well as to the international standards.

Macrogeometric errors due to manufacturing process. Definition of design or functional tolerances and manufacturing tolerances; natural tolerances and productivity. ISO tolerance systems; Criteria for the selection of dimensional tolerances according to functional conditions, and recommended fits. Definition of general tolerances. Limit dimensions, deviations and their calculation. International tolerance grades and fundamental deviations. Graphic representation for deviations. Minimum and maximum material conditions.
Microgeometric errors due to manufacturing process. Surface finishing and roughness parameters. Evaluation of the average roughness. Mean profile: formula and demonstration. Integral and discrete roughness. Selection of roughness and typical values in the case of simple machine elements. Relationship between roughness and tolerances. Tolerance limit values related to specific values of average roughness.

[2 CFU] The third part of the Course is devoted to the study concerning the representation of the main connection parts for mechanical systems. The study of assemblies consisting of several machine components allows to analyse the contribution that each part makes to the functioning of the machine or the mechanical system.

Permanent and removable fasteners. Threads: Metric, Whitworth, Gas, Trapezoidal and Buttress. Designs of screws and nuts. Threads for fastener screws and manoeuvring screws. Designation of threaded fasteners: cap screw, bolt and studs. Functioning of screw-nut couple; actions of threaded parts and reactions of connected parts; mechanical stress analysis for screw stem and failure conditions for screw; the technical problem of spontaneous unscrewing; Junker Test; devices to avoid unscrewing. Non-threaded removable fasteners - (tapered) keys and parallel keys; functioning principle – friction and mechanical obstacle; typical shapes for parallel keys (A, B and C); Woodruff keys; typical shapes for (tapered) keys (A, B and C), gib-head key and tangent key; saddle and hollow keys; technical problems and selection according to the several typologies and functioning conditions; selection of parameters (width, height and length) through technical standards and dimensioning; characteristic features of splined shafts. Pins, split pins, elastic rings (e.g., Seeger-ring). Spring: typology and typical applications. Representation elements of permanent fasteners: definition and representation of hot and cold riveted joints, morphological features and placement on the parts to be connected. Representation of welded joints and welding symbols. Analysis of mechanical assemblies. Motion transmission systems. Rigid and elastic joints, universal joints; representation and functioning of machine elements such as transmission shafts, sliding bearings, pulleys, belts, connecting rod, crank, crankshafts, gears and rolling bearings.

READINGS/BIBLIOGRAPHY

Main Textbook

Chirone E. e Tornincasa S., Disegno Tecnico Industriale, two volumes, Il Capitello. Ed. 2018-19.
Free of charge MOOC Course on FEDERICA platform: Lanzotti A., Disegno Tecnico Industriale, WWW.FEDERICA.eu
Carfagni M. et al., Esercitazioni di Disegno Meccanico, Zanichelli, 2020, II Ed.
Barone S. et al., Disegno Tecnico Industriale, Città Studi Ed.,2020.
All students will find presentations and teaching material related to classroom exercises on the professor's website and TEAMS platform.
UNI-EN-ISO standards are available in library.
Caligaris et al., Manuale di Meccanica, HOEPLI Ed.
Baldassini e Fiorineschi, Vademecum per disegnatori e tecnici, HOEPLI Ed.

TEACHING METHODS

a) Frontal lessons for about 60 percent of the program hours.
b) Classroom exercises, for about 40 percent of the program hours (also on MS TEAMS), for practical insight into the theoretical features, to discuss about graphic works and to manage learning tests towards the self-assessment.
c) MOOC Course "Disegno Tecnico Industriale" (in synchronous mode on Federica Web Learning) for further insight into the topics, and TEAMS platform for self-assessment tests with multiple choice answers and supplementary multimedia material.

EXAMINATION/EVALUATION CRITERIA

Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
Other	

In case of a written exam, questions refer to: (*)		
	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

The minimum requirements for passing the exam concern the following features: i) knowledge of the representation method of orthogonal projection using views and sections of a 3D object in axonometry; ii) ability to calculate dimensional tolerances and fits according to the international standard.
The students must use the main textbook, manuals or collection of technical standards during the written test.
The students with SLD (Specific Learning Disorders) or disabilities can use teaching support material, such as synoptic tables and multimedia devices, with the aim to help the learning process.
The oral test focuses on the subjects of the program and starts from the discussion of the graphic works made by the students and presented through engineering drawings developed during practical lessons.

Evaluation criteria:

All the students carry out a written test, which does not limit the access to the oral test.
All the students discuss about the written test in order to check the errors and to justify the choices they made.
All the students show the engineering drawings developed during practical lessons in the year.

COURSE DETAILS

GEOMETRY AND ALGEBRA

SSD MAT/03

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: DEPENDS ON THE GROUP
PHONE:
EMAIL:

SEE DEGREE COURSE PROGRAM WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME (I, II, III): I
SEMESTER (I, II): DEPENDS ON THE GROUP
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

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PREREQUISITES (IF APPLICABLE)

The mathematical content of school syllabus.

LEARNING GOALS

Students should learn all the basic tools of linear algebra and geometry. The goal of this course is, on one hand, to get used to afford formal problems by using adequate tools and correct language, on the other hand to solve specific problems of algebraic or geometric type, applying the methods of linear algebra.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Students are requested to prove to be acquainted with notions (definitions, statements, proofs, if specifically indicated in the syllabus) related to the known algebraic and geometric structures (vector spaces, the plane and the space of the elementary geometry, matrix spaces) and the calculation tools developed during the course. They should be able to understand topics like those learned, by reworking known notions.

Applying knowledge and understanding

Students should be able to apply what they learned in solving suitable exercises elaborated by the teacher, mainly related with lines and planes, matrices, equations, vectors, and they should know the basic problematics related to algebraic and geometric structures.

COURSE CONTENT/SYLLABUS

Recalls on set theory and algebraic structures: 0.5 CFU

Union, intersection, complement, cartesian product; correspondences and relations, maps, restrictions: injective, surjective, and bijective maps. Composition of maps. A characterization of bijective maps. Equivalence relations (the congruence of applied vectors as an example). Internal operations: associativity, neutral element, symmetric elements, commutativity (the sum on numers and on vectors an example). Abelian and non-abelian groups (with some examples). Fields. The example of real numbers and the prime field of order 2. External operations (multiplication on vectors as an example).

Vector spaces and Euclidean spaces: 1.5 CFU

Definition and elementary properties of a vector space. Examples: numerical vector spaces, polynomials, matrices, vectors of the elementary geometry. Linear combinations. Linear dependence and independence, and their characterizations. Generators. Subspaces and their characterizations. The linear spam of a subset of vectors. Bases of a vector space, and related components. Extraction of a basis from a set of generators. The Steinitz lemma and its consequences: the dimension of a vector space, the construction of a basis starting from a linearly independent set of vectors. Intersection, sum, direct sum of subspaces. The Grassmann formula. The notion of Euclidean vector spaces: inner products in real vector spaces, the length of a vector, angles between vectors, orthonormal bases. The Gram-Schmidt process. Orthogonal complements. The standard inner product on numerical vector spaces. The inner product between geometric vectors. The vector product in 3-dimensional spaces.

Matrices and determinants: 1 CFU
Elementary operations on the rows of a matrix and stepped matrices. The rank of a matrix and the number of pivots of a stepped matrix. Triangular and diagonal matrices. The row-by-column product. The notion of determinant of a square matrix: classical definition and elementary properties (without proofs). Characterization of the maximum rank of a square matrix by the non-vanishing of their determinants. Computation of determinants: first and second Laplace theorems, Kronecker theorem (without proof). Invertible matrices and the determination of the inverse. Similarity of matrices.

Linear systems of equations: 1 CFU
Solutions, compatibility and Rouchè-Capelli theorem. Cramer theorem and Gauss elimination algorithm. Resolution of a linear system. Determination of a basis of the vector space of solutions of a homogeneous linear system. Each subspace of a numerical vector space is the space of solutions of a homogeneous linear system. Cartesian and parametric representation of subspaces of numerical vector spaces.

Linear maps: 0.5 CFU
The notion of linear map: elementary properties. Linear maps preserve linear dependence. Kernel and image of a linear map. A characterization of injective and surjective linear maps. The fundamental theorem of linear maps. Endomorphisms and isomorphisms. The isomorphism associated to given bases. The transition matrices associated to a change of bases. The rank-nullity theorem (without proof). Similarity of matrices associated to a given endomorphism in different bases.

Diagonalization of endomorphisms and matrices: 0.5 CFU
Eigenvalues, eigenvectors, and eigenspaces of endomorphisms (and square matrices). The characteristic polynomial. Algebraic and geometric multiplicity of an eigenvalue. Characterization of the diagonalizability of endomorphisms and square matrices through the existence of a basis of eigenvectors. Determination of the eigenvalues and of a basis of eigenvectors of a diagonalizable endomorphism or square matrix.

Affine Euclidean spaces: 1 CFU
Basic definitions. Affine frames and coordinates of a point. Affine Euclidean subspaces. Parallelism among subspaces. Skew lines. Cartesian and parametric representation of affine (Euclidean) subspaces. The study of incidence and parallelism of subspaces. Orthogonality conditions among subspaces in dimension 2 or 3. Distance among subsets of points. Distance among a point and a hyperplane. The distance between Euclidean subspaces in dimension 2 or 3. The common perpendicular theorem. Proper and improper pencils of straight lines (in dimension 2) and planes (in dimension 3).

READINGS/BIBLIOGRAPHY

DEPENDS ON THE GROUP

TEACHING METHODS

Plenary lectures. Approximately one third of the lectures will be based on exercises.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	x
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	X
	Open answers	X
	Numerical exercises	X

(*) multiple options are possible

b) Evaluation criteria:

The grade is formulated by the Examination Commission on the basis of the outcome of written test, in particular on the basis of the consistency and accuracy of the exercises performed and the adequacy of the answers provided by the student to the theory questions. The final grade is also suitably motivated to the student.

COURSE DETAILS

MATHEMATICAL ANALYSIS II

SSD MAT/05

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: DEPENDS ON THE GROUP
PHONE:
EMAIL:

SEE DEGREE COURSE PROGRAM WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME (I, II, III): I
SEMESTER (I, II): II
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Mathematical Analysis I

PREREQUISITES (IF APPLICABLE)

LEARNING GOALS

To provide the fundamental concepts, in view of the applications, relating to the differential and integral calculus for real functions of several real variables, and to ordinary differential equations; do acquire conscious operational skills.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The students will have to demonstrate knowledge of the notions (definitions, statements, proofs if provided by the program) related to infinitesimal, differential and integral calculus for real functions of several real variables and the developed calculation tools and be able to understand related topics by elaborating the notions acquired.

Applying knowledge and understanding
The students must prove that they are able to apply what they have learned in solving exercises developed by the teacher, related to topics such as: sequences and series of functions, limits and graph of functions of several variables, multiple integration, ordinary differential equations and Cauchy problems.

COURSE CONTENT-SYLLABUS

(0.5cfu) Complex numbers. Definition and properties. Sum and product operations. Algebraic form and trigonometric form. Powers and roots of a complex number. Euler's formulas, exponential form.

(1 cfu) Sequences and series of functions. Pointwise and uniform convergence; pointwise and uniform Cauchy convergence criteria. Theorems on the continuity of the uniform limit, of passage to the limit under the sign of integral and derivative. Absolutely convergent and totally convergent series; Cauchy criteria for series; total convergence and uniform convergence. Continuity theorems of the uniform sum of a series, of integration by series and derivation by series. Power series. Taylor series: developability and remarkable developments. Analytic functions.

(2.5 cfu) Differential calculus for functions of several variables.
Elements of topology. Euclidean distance; definition of neighborhood. Internal, external points, boundary points. Open and closed sets; cluster points and isolated points. Bounded sets; Bolzano-Weierstrass theorem. Compactness and characterization of compacts. Convexity and connected sets. Functions of several variables: limits, continuity and relative properties; Weierstrass theorem. Partial derivatives; differentiability and total differential theorem; directional derivatives and gradient; derivation of composite functions. Functions with null gradient in a connected domain. Higher order derivatives and Schwarz's theorem. Lagrange's theorem. Taylor's formula of the first and second order. Relative extrema: necessary condition of the first order. Relative extrema of functions of two variables: necessary condition of the second order, sufficient condition of the

second order. Search for absolute maxima and minima of continuous functions in compact sets of the plane. Relative extrema of functions of three variables: sufficient conditions. Positively homogeneous functions, Euler's theorem.

(0.5cfu) Implicit functions. Local equivalence of a plane curve with a graph. Dini's theorem for equations of the type f (x, y) = 0. Constrained maxima and minima of functions of two variables. Lagrange multiplier theorem.

(0.5 cfu) Curves. Regular and piecewise regular curves: tangent line; oriented curves. Length of a curve, rectifiability of regular curves. Curvilinear abscissa. Curvature of a plane curve. Curvilinear integral of a function.

(1 cfu) Multiple integrals. Double integrals on normal domains. Integrability of continuous functions. Reduction formulas for double integrals. Change of variables in double integrals. Triple integrals; reduction formulas; change of variables. Solids of rotation and Guldino's Theorem.

(1 cfu) Surfaces. Smooth surfaces: tangent plane; orientable surfaces; surfaces with boundary; closed surfaces. Area of a surface. Surfaces of rotation and Guldino's Theorem. Surface integral of a function. Flow integrals of a vector field. Divergence theorem in R3

(1 cfu) Linear differential forms. Exact differential forms and conservative fields. Curvilinear integral of a linear differential form. Integration criterion of differential forms. Closed differential forms. Poincaré's lemma. Radial forms. Homogeneous forms. Gauss-Green formulas in the plane. Divergence theorem in the plane. Stokes formula in the plane. Differential forms, closed in simply connected open of the plane. Differential forms in space. Irrotational fields. Stokes formula in R3. Differential forms closed in simply connected open spaces of space.

(1 cfu) Differential equations. Cauchy problem for differential equations of order n: local and global existence and uniqueness theorems. General integrals; singular integrals. Linear differential equations of order n: theorem on the general integral of a homogeneous equation, Wronskian theorem, theorem on the integral of a complete equation. Linear equations of the first order; linear equations with constant coefficients. Method of variation of constants. Equations with separable variables. Equations of the form y '= f (y / x). Bernoulli equations. Equations of the form y '' = f (x, y ')

READINGS/BIBLIOGRAPHY

CHECK THE TEACHER WEBSITE

TEACHING METHOD

The lessons will be face to face, and about one third of the lessons will be of exercises.

EXAMINATION/EVALUATION CRITERIA

a) Type of exam:

Exam type	
written and oral	x
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	Multiple choice answers	X
	Open answers	X
	Numerical exercises	X

(*) multiple options are possible

b) Evaluation criteria:

The grade is formulated by the Examination Commission on the basis of the outcome of written test, in particular on the basis of the consistency and accuracy of the exercises performed and the adequacy of the answers provided by the student to the theory questions. The final grade is also suitably motivated to the student.

COURSE DETAILS

CHEMISTRY

SSD CHIM/07

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

LEARNING GOALS

Deep knowledge of main chemical and chemical-physical foundations to study and understand the behavior and transformation of matter in the field of technologies and industrial applications: materials, storage and production of energy and environmental pollution.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate that he has achieved an adequate knowledge of the laws of physical and chemical transformations with special reference to both irreversible and equilibrium reactions.

Applying knowledge and understanding

At the end of the course the student must demonstrate that he has acquired the ability to manage in a quantitative way both irreversible and equilibrium reactions.

COURSE CONTENT/SYLLABUS

[1 CFU] The matter and its properties*. Atomic theory fundamentals and Stoichiometry. The laws of chemical combinations. Atomic mass. The mole and molar mass. Chemical formulas. The balance of the chemical equation and stoichiometric calculations.*

[2 CFU]. *Atomic structure and chemical bond. The model of the hydrogen atom. Atomic orbitals. The periodic Table of Elements. The covalent bond. Multiple bonds. Molecular geometry. The polarity of molecules in relation with their structure. The ionic bond. Oxidation number. Redox equations. The nomenclature of the main inorganic compounds. The bond in organic molecules: the main functional groups.*

[1 CFU] The states of the matter*. The gaseous state. The distribution of molecular rates. The weak interactions. The real gas. The liquid state. The solid state. Metallic solids: the bands model of the metallic bond. Physical equilibria. The principles of the thermodynamic. The phase diagrams of a single component. The solutions and their properties.*

[1 CFU] The *chemical kinetic. The rate of the reaction. Reaction mechanisms. The activation energy. Catalysts. Chemical reactions: spontaneity and the equilibrium condition in the chemical reactions, the factor the affect the chemical equilibrium.*

[1 CFU] Acid-base and solubility equilibria*. Redox reaction and electrochemistry. Galvanic cells and electrochemical potentials. Electrolysis.*

READINGS/BIBLIOGRAPHY

Textbooks; Slides of the course. Multimedial MOOC course of Chemistryavalaible on the e-learning informatic plataform of the University "Federica"**: https://www.federica.eu/mooc/c/chimica.**

TEACHING METHODS

Lessons; laboratory exercises at the wind tunnel.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	X

b) Evaluation criteria

COURSE DETAILS

ELEMENTS OF COMPUTER SCIENCE

SSD ING-INF/05

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

None

PREREQUISITES, IF ANY

None

LEARNING GOALS

The course aims to provide students with the basic notions related to the structure and functional model of a computer, the fundamental data structures and the tools and methods for the development of programs, on a small or medium scale, for technical and scientific applications.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate that he/she has reached an adequate knowledge of the theoretical formulations, of the basic operation of a computer and has understood the principles of programming as well as the mechanisms of translation from high-level languages to machine language.

Applying knowledge and understanding

At the end of the course the student must demonstrate that he/she has developed computational thinking, that is the ability to design and code algorithms in a high-level programming language, according to the techniques of structured and modular programming, for solving numerical computing problems of limited complexity and management of data sets, even multidimensional.

COURSE CONTENT/SYLLABUS

[1 CFU] the concept of "information"; representation and encoding of information; introduction to boolean algebra; propositional logic; logical connectives; boolean algebra properties; boolean functions and truth tables; De Morgan's theorem;

[1 CFU] the executor model; processes and processors; Von Neumann model; memories; the CPU; the bus; the clock; firmware, software, and middleware; evolution of the Von Neumann model; the abstract executor model.

[1 CFU] computer science as the study of algorithms; problem solving: computability of algorithms; finite state automata; Turing machine; Universal Turing Machine; Church and Turing thesis; hints at tractability and computational complexity; the description of algorithms; static and dynamic sequence of algorithms; programming languages.

[1 CFU] programming language sentences; control structures; code modularity and parameterization; subprograms, procedures, and functions; parameter exchange; information and data; type classification; translation process; compilation; linking; loading; interpreters; checking programs for correctness; embedded environments.

[2 CFU] THE C++ LANGUAGE: introduction, general characteristics of the language; arrays; structs; libraries for handling character strings; scope and visibility, global and local variables, storage classes;, control structures in

C++; basic algorithms in C++, handling one-dimensional and multi-dimensional vectors (insertion, deletion, searching, sorting); examples and exercises of programming in c++.

READINGS/BIBLIOGRAPHY

Chianese A., Moscato V., Picariello A. (2017) "Le radici dell'Informatica. Dal bit alla programmazione strutturata". Maggioli Ed.
Burattini E., Chianese A., Moscato V., Picariello A., Sansone C. (2016) "Che C serve? Per iniziare a programmare", Maggioli Ed.
Slides and supplementary handouts at teachers' sites

Additional References

Chianese A., Moscato V., Picariello A. (2008) "Alla scoperta dei fondamenti dell'Informatica. Un viaggio nel mondo dei bit". Liguori Ed.

TEACHING METHODS

Lessons; laboratory and programming exercises.

EXAMINATION/EVALUATION CRITERIA

a) **Exam type:**

Exam type	
written and oral	X
only written	
only oral	
project discussion	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Programming Test	X
	Numerical exercises	

(*) Multiple options allowed

b) **Evaluation modalities:**
The grade is formulated by the Examination Committee based on the adequacy of the answers given by the student to the questions posed to him/her.
In addition, the final grade is appropriately motivated to the student.

COURSE DETAILS

GENERAL PHYSICS I

SSD FIS/01

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: I
SEMESTER: II
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

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PREREQUISITES

Sufficient knowledge of basic mathematical tools, as well as a reasonable knowledge of the contents of the courses of Mathematical Analysis I and Algebra and Geometry.

LEARNING GOALS

The course aims to provide students with the basic notions and concepts of kinematics and dynamics of material points and rigid bodies, focusing on phenomenological and methodological aspects. Students will also acquire a conscious operational ability in solving numerical exercises.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate knowledge and understanding of the theoretical and experimental foundations of mechanics, with reference to conservation laws and energy aspects. He must also acquire the ability to describe mechanical problems of the material point and of the rigid body by adopting correct terminology. Finally, the student must be able to understand the physical-mathematical conceptual schemes and tools necessary for learning scientific knowledge in general and to successfully tackle subsequent courses in physics, applied physics and engineering.

Applying knowledge and understanding

At the end of the course the student must demonstrate that he has acquired the ability to apply the knowledge learned to solve in a quantitative way relatively simple problems of mechanics of the material point and of the rigid body. The training course is aimed at transmitting the ability to select the known information of a problem and to introduce the appropriate schematizations and simplifications for its solution.

COURSE CONTENT/SYLLABUS

Kinematics and motion; Newton’s laws of dynamics; Characteristics of force; Work and potential energy; Conservation of energy, and linear and angular momentum; Dynamics of a rigid body; Theory of gravitation; The harmonic oscillator; The statics of fluids.

READINGS/BIBLIOGRAPHY

Main Textbook

D. Sette, A. Alippi e A. Bettucci, Lezioni di Fisica I (Meccanica - Termodinamica), Zanichelli;
P. Mazzoldi, M. Nigro, C. Voci, Elementi di Fisica (meccanica e termodinamica), EdiSES;
P.A. Tipler, Corso di Fisica vol. 1° (Meccanica e Termodinamica), Zanichelli Editore;
D, Halliday, R. Resnick, J. Walker, Fondamenti di Fisica (Meccanica, Termologia, Elettrologia, Magnetismo, Ottica), Casa Editrice Ambrosiana;
W.E. Gettys, Fisica 1, McGraw-Hill;
R. A. Serway e J.W. Jewett, Fisica (per Scienze ed Ingegneria), Vol. 1, EdiSES.

TEACHING METHODS

The teacher will dedicate about 2/3 of the total hours of the course to lectures and the remaining time will be dedicated to numerical exercises.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

COURSE DETAILS

AERODYNAMICS

SSD ING-IND/06

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: I
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Mathematical Analysis II, General Physics

LEARNING GOALS

The course aims to introduce the student to the physical principles of Aerodynamics, explaining the genesis of aerodynamic forces, deriving the general equations for the different regimes of Aerodynamics. The cultural background for the study of problems of Aerodynamics is provided by introducing the general concepts of characteristic numbers, the boundary layer, the orders of magnitude analysis and the small perturbations thoery. The classical lifting wing theories and the main aerodynamic characteristics of wing airfoils and finite wings are also illustrated.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate that he has achieved an adequate knowledge of theoretical formulations, physical-mathematical modeling and phenomenologies associated to the interaction due to the relative motion between a fluid and a body and the consequent aerodynamic actions.

Applying knowledge and understanding

At the end of the course the student must demonstrate that he has acquired notions to be applied to solve classical problems in the field of aerodynamics.

COURSE CONTENT/SYLLABUS

[1 CFU] Typical phenomenologies of Aerodynamics - Principles of flight - Genesis of lift. Magnus effect. Effects of viscosity. Friction and wake resistance - Characteristics of the Earth's atmosphere.

[2 CFU] References to equilibrium thermodynamics. Balance equations. Elements of tensor calculus. Kinematics of fluids. Stress tensor. Phenomenological relations. Characteristic numbers and their kinematic, dynamic, energetic interpretation. Generalized Crocco's theorem. Bernoulli's theorem. Speed circulation and vorticity. Theorems of Stokes, Helmoltz, Kelvin. Equations of non-viscous flow in intrinsic coordinates.

[1 CFU] Potential incompressible flows. Potential function and streamfunction. Laplace equation and boundary conditions. Principle of superposition of different solutions. Particular solutions. Combination of basic solutions. Potential flow around a circular cylinder.

[2 CFU] Notes on the lifting theory of wings. Small perturbation theory. Aerodynamic coefficients and their dependence on geometry, angle of attack, Reynolds and Mach numbers. Moment coefficient. Center of pressure and aerodynamic center. Wing airfoils, NACA airfoils series and solution method. Effects of compressibility. Subsonic similarity. Prandtl-Glauert equation. Critical Mach number.

[1 CFU] Notes on transonic flight. The aerodynamic behaviour of airfoils in transonic field. Swept wing.

[1 CFU] Boundary layer. Orders of magnitude analysis and Prandtl equations. Boundary layer and displacement thickness. Friction. Boundary layer separation. Main features of the boundary layer on flat plate. Notes on the turbulent boundary layer.

[1 CFU] Direct and indirect lift and drag evaluation methods. Kutta–Joukowsky theorem. Lancaster-Prandtl lifting-line theory of a finite wing. Induced drag. Elliptical loading on the wing. Aircraft drag polar.

READINGS/BIBLIOGRAPHY

Main Textbook

Aerodinamica Parte I e Parte II R. Monti e R. Savino, Liguori Editore); Slides of the course.
Students are also provided with photocopies of data and graphs useful both for classroom and laboratory exercise purposes.

Additional References

Fundamentals of Aerodynamics , John Anderson
McGraw-Hill Education

TEACHING METHODS

Lessons; laboratory exercises at the wind tunnel.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	
only written	
only oral	X
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	

COURSE DETAILS

MATHEMATICAL PHYSICS

SSD MAT-07

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")
Analisi Matematica I, Geometria e Algebra

LEARNING GOALS
The course aims to introduce the student to the principles and methodologies of Rational Mechanics, starting from the Newtonian Dynamics, by showing the main principles and equations of Statics and Dynamics. The cultural background for the study of problems of Statics and Dynamics of systems of rigid bodies is provided.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The student must demonstrate that he has achieved an adequate knowledge of theoretical formulations, of physical-mathematical modelling and phenomenologies associated to the equilibrium and the motion of sets of rigid bodies, free or constrained.

Applying knowledge and understanding
At the end of the course the student must demonstrate that he has acquired notions to be applied to solve classical problems of statics and dynamics of systems of rigid bodies.

COURSE CONTENT/SYLLABUS

[1 CFU] Review of vector calculus. General theory of applied vectors. Central axis.

[1 CFU] Centre of mass and its properties. Moment of inertia. Inertia tensor. Principal axis, and use of symmetries in their determination. Ellipsoid of inertia.

[1 CFU] Kinematic of a point and of a rigid body. Poisson's rules. Velocity of a rigid body. Infinitesimal displacements. Virtual displacements. Relative motions. Theorems of composition of velocities and accelerations.

[2 CFU] Forces. Work, power, and energy. Newton's Laws. Inertial spaces. Relative dynamics. Galileo relativity principle. Dynamics Equations for a general material system. Dynamics of a free or constrained rigid body. Reaction forces.

[1 CFU]. Isostatic, iperstatic and frail systems. General principles of Statics. Statics Equations. Virtual Work Principle. Computation of external and internal constraints. Gerber beams. Plane trusses. Ritter and hinges method.

READINGS/BIBLIOGRAPHY
Main Textbook
Biscari, Ruggeri, Saccomandi, Vianello. Meccanica Razionale. Springer

Additional References
D'Acunto, Massarotti: Meccanica Razionale per Ingegneria. Maggioli Editore.

TEACHING METHODS

Lessons; classroom exercises.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

COURSE DETAILS

FLIGHT MECHANICS- PERFORMANCE

SSD ING-IND/03

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE THE WEBSITE OF THE DEGREE PROGRAMME

GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: MECCANICA DEL VOLO
MODULE: PRESTAZIONI

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Analisi Matematica I, Geometria e Algebra, Fisica Generale

PREREQUISITES (IF APPLICABLE)

Basic knowledge of mathematics and general physics.

LEARING GOALS

The student will acquire the fundamental concepts concerning the flight principles. Through lessons of theory and a wide range of exercises, this course will provide the student with the required knowledge and instruments to predict all the key aircraft performance (i.e., take-off and landing distances, climb, steady level flight, turn, range, endurance, etc.).

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS

Knowledge and understanding
The student must have achieved an adequate knowledge of the basic elements of flight principles and theoretical formulations to estimate aircraft performance.

Applying knowledge and understanding
The student must demonstrate that he/she is able to apply the concepts acquired in the estimation of flight performance of propeller as well as jet driven aircraft.

COURSE CONTENT/SYLLABUS

[1 CFU] International Standard Atmosphere model. Classification of aircraft. Characteristics of different type of aircraft (light aircraft, turboprop, transport jet). Fundamentals of aerodynamic, pitot probe, airspeed and, flight altitude measuraments. Aerodynamic drag and induced drag.

[1 CFU] Understanding aerodynamic lift, global theory. Compressibility effects (critical Mach number). Parabolic drag model (examples and applications, typical values for several types of aircraft).

[1 CFU] Aircraft drag polar curves, drag and power required for steady level flight. Effects of flight altitude and aircraft weight. Characteristic points of aircraft drag polar curve. Description and models of propulsion systems. Piston engines, turboprops, turbofan, jet engines. Fundamentals of propeller. Exercises of drag, required power and thrust, fuel consumption estimation for jet and propeller driven aircraft.

[1 CFU] Performance in steady level flight. Estimation of the maximum cruise speed or the maximum achievable speed at a specific throttle setting. Application methods for propeller and jet driven aircraft. Climb performance, force scheme and equations. Fastest and steepest climb speeds. Definitions of climb ceilings. Analithical approach for propeller and jet driven aircraft.

[1 CFU] Exercises and tutorials about climb performance, time to climb, ceilings for propeller and jet driven aircraft. Climb performance in One Engine Inoperative conditions. Gliding flight – theory and exercises. Range and Endurance of propeller and jet driven aircraft. Breguet's formula. Exercises and tutorials. Hints about the effects of the wind.

[1 CFU] Turning performance. Applications on propeller and jet driven aircraft. Take-Off performance. Balanced Field Length. Ground Roll Distance – approaches and methods. Exercises and applications. Landing performance and landing distance.

READINGS/BIBLIOGRAPHY

Slides
Lecture notes of the course
J.D. Anderson; *Introduction to Flight;* McGraw-Hill Book Company

TEACHING METHODS

Lessons of theory and a large number of exercises and practical applications.

EXAMINATION/EVALUATION CRITERIA

b) Exam type:

Exam type	
written and oral	
only written	X
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) Multiple options are possible

c) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the outcome of the written test. The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

AEROSPACE SYSTEMS I

SSD ING-IND/05

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

Calculus II, Geometry and Algebra, General Physics

PREREQUISITES (IF APPLICABLE)

Basic knowledge of mathematics and general physics.

LEARNING GOALS

The course aims to provide the essential topics for mathematical-physical modeling, for studying the dynamics and control and the analysis of the dynamic performance of aerospace systems. Some integrated realization solutions are studied in detail, with particular reference to applications in the aeronautical field, with the aim of enabling the student to master, at a first level of study, the basic theoretical problems that lead to the definition of a controller.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate that he/she has achieved an adequate knowledge of the theoretical, mathematical and physical formulations, which describe the dynamic and control performance of aerospace systems.

Applying knowledge and understanding

The student must demonstrate that he/she is able to apply the concepts acquired in the study of aerospace systems, with reference to aeronautical applications, to the stability analysis of a system and to the design of a controller.

COURSE CONTENT/SYLLABUS

[3 CFU] Linearized mathematical-physical models of systems by means of representation with state variables, motion in the state space. Equilibrium, stability analysis of equilibrium points, stability criteria, equations of state and output equations, state transition matrix and transfer function matrix. Examples for first and second order systems, performance study in terms of unit impulse, unit step and periodic responses, frequency response, numerator dynamics.

[2 CFU] Open loop and closed loop systems, feedback control, linear control logic, design and study of the performance of P-I-D controllers using analytical and graphical methods.

[1 CFU] Models of hydraulic actuators and servo-actuators and examples of realizations based on mechanical transmission and on fly-by-wire logic for the deflection of mobile aerodynamic surfaces.

READINGS/BIBLIOGRAPHY

Course notes available on the teacher web site.

Further reading: Blakelock, J.H., Automatic Control of Aircraft and Missiles, 2nd ed.,1991, John Wiley & Sons; Hale, F.J., Introduction to control system analysis and design, 1988, Prentice-Hall International; McLean, D., Automatic Flight Control Systems, 1990, Prentice Hall International; Oppenheim, A.V., Willsky, A.S., e Young, I.T., Signals and systems, 1983, Prentice-Hall International; Palm III, W.J., Modeling, analysis, and control of dynamical systems, 1983, John Wiley & Sons.

TEACHING METHODS

Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA

d) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) multiple options are possible

e) Evaluation pattern:

The grade is formulated by the Examination Commission based on the outcome of the written test and the adequacy of the answers provided by the student to the questions asked during the oral test.
The final grade is also suitably motivated to the student.

COURSE DETAILS

THERMO-FLUID DYNAMICS

SSD ING-IND/06

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

INFORMAZIONI GENERALI - ATTIVITÀ

INTEGRATED COURSE: GASDINAMICA
MODULE: GASDINAMICA

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")
Analisi Matematica II, Fisica Generale

PREREQUISITES
Basic knowledge of mathematics and physics.

LEARNING GOALS
The course is aimed at aerospace engineering students and its goal is to introduce the physical principles of equilibrium thermodynamics and thermodynamic cycles; to provide the basic cultural background for the study of fluid mechanics problems, highlighting the connections with thermodynamics; to describe the fundamental mechanisms of heat transfer and their applications.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
Students should achieve adequate knowledge of the theoretical formulations that describe fluid mechanics and their connections with thermodynamics.

Applying knowledge and understanding
Students should demonstrate that they are able to apply the concepts, learned in the study of the thermo-fluid dynamic phenomena, by solving simple heat transfer problems.

COURSE CONTENT/SYLLABUS

[1 CFU] Equilibrium thermodynamics. Internal energy. Equations of state. Gas models, Perfect gas. 1° and 2° Laws of Thermodynamics.

[1 CFU] Elementary thermodynamic transformations. Carnot Cycle and Entropy. Thermodynamic cycles (Otto, Diesel, Brayton). Axiomatic approach to Thermodynamics. Fundamental equation. Conjugate variables. Thermodynamic stability. Specific heat coefficients and speed of sound. Thermodynamic potentials. Fluid dynamic integral balance equations for closed and open systems. Reynolds transport theorem. Mass and energy conservation equations. Entropy balance equation (2° law of Thermodynamics).

[1 CFU] Momentum balance equation. Stress tensor. Newtonian fluids. Quasi-one-dimensional steady-state flows. Bernoulli equation for incompressible and compressible flows. General thrust equation.

[1 CFU] Heat transfer mechanisms. Heat conduction. Classic one-dimensional heat conduction problems and solutions.

[1 CFU] Radiative heat transfer. Fundamental equations (Planck's and Stephan-Boltzmann equations). Emissivity coefficients. View factors. Radiative heat exchange.

[1 CFU] Convective heat transfer. Forced convection. Boundary layer properties. Reynolds analogy. Nusselt number correlations for internal and external laminar and turbulent flows. Natural convection.

READINGS/BIBLIOGRAPHY

Lecture notes, available on the web at https://www.docenti.unina.it.
E. Fermi, Thermodynamics, Dover;
M.C. Potter, C.W. Somerton, Termodinamica per ingegneri, McGraw-Hill;
G.M. Carlomagno, Elementi di Gasdinamica, Liguori;
I. G. Currie, Fundamental Mechanics of Fluids 3rd Ed., Marcel DeKker Inc.,
F.M. White, Viscous Fluid Flow, McGraw-Hill;
Baher, K. Stephan, Heat and Mass Transfer, Springer.

TEACHING METHODS

Lectures and numerical exercises.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	
only written	
only oral	X
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	

(*) More options are allowed

b) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the correctness of the answers provided by the student.
The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

GASDYNAMICS

SSD ING-IND/06

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

INFORMAZIONI GENERALI - ATTIVITÀ

INTEGRATED COURSE: GASDINAMICA
MODULE: GASDINAMICA

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Analisi Matematica II, Fisica Generale

PREREQUISITES

Basic knowledge of mathematics and physics.

LEARNING GOALS

Acquisition of the foundations of Gasdynamics and the analysis of motions in compressible regime. Learn the use of elementary methods for the calculation of supersonic flows and one-dimensional motions. Solution of dissipative motions with integral methods.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Students should achieve adequate knowledge of the theoretical formulations that describe compressible flows.

Applying knowledge and understanding

Students should demonstrate that he is able to apply the concepts, learned in the study of the compressible flows.

COURSE CONTENT/SYLLABUS

[1.5 CFU] Stagnation condition. Velocity of propagation of small pressure disturbances. Flow in ducts with variable area. Normal shock waves. Unsteady shock waves. Oblique shock waves. Supersonic flow around a wedge. Shock polar. Reflections of shock waves. Conical shock waves.

[1.5 CFU] Prandtl and Meyer expansion. Diamond shaped profiles. Nozzles. Mass flowrate in a nozzle. Convergent nozzle connected to a reservoir. Conditions of efflux from an under-expanded convergent nozzle. Convergent-divergent nozzle connected to a reservoir. Mass flowrate in a convergent-divergent nozzle. Efflux from a convergent-divergent nozzle.

[1.5 CFU] Tank emptying. Stability of shock waves in a variable area duct. Supersonic wind tunnels. Subsonic and supersonic inlets.

[1.5 CFU] Introduction to Fanno flow. Influence of Mach number for Fanno flow. Fanno duct connected to a converging nozzle. Fanno duct connected to a convergent-divergent nozzle. Adiabatic wall temperature. Isothermal flow. Introduction to Rayleigh flow. Influence of Mach number for a Rayleigh flow. Rayleigh duct connected to a converging nozzle. Rayleigh duct connected to a convergent-divergent nozzle.

READINGS/BIBLIOGRAPHY

G. M. Carlomagno, Elementi di Gasdinamica, 2009.
Anderson, J. D., Modern Compressible Flow, 1990.
Hodge B. K. and E K. Koenig, Compressible Fluid Dynamics: With Personal Computer Applications, 1995.
Shapiro, A. H., The Dynamics and Thermodynamics of Compressible Fluid, Vol. I and II, 1953.

Zucrow M. J. and J. D. Hoffman, Gas Dynamics, Vol. I, John Wiley & Sons, 1976 - Vol. II, 1985.

TEACHING METHODS

Lectures and exercises, requiring pocket calculators, for applying and learning the theoretic formulations. Multimedia material as auxiliary tool.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	X

(*) More options are allowed

b) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the scores achieved by the student in the written and oral exams.

The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

FLIGHT MECHANICS- MANEUVERS AND STABILITY

SSD ING-IND/03

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION – TEACHER REFERENCES

FUORIGROTTA:

TEACHER:
PHONE:
EMAIL:

SAN GIOVANNI:

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

INFORMAZIONI GENERALI - ATTIVITÀ

INTEGRATED COURSE: MECCANICA DEL VOLO (FLIGHT MECHANICS)
MODULO: MANOVRE E STABILITÀ (MANEUVERS AND STABILITY)

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Analisi Matematica II, Geometria e Algebra, Fisica Generale

PREREQUISITES (IF APPLICABLE)

Basic knowledge of mathematics and general physics.

LEARNING GOALS

The course is organized in two parts. The objective of the first part is to provide the student with the tools to evaluate the equilibrium and static stability characteristics of an airplane, in stick-fixed and stick-free condition, in both the longitudinal and the lateral-directional plane. In-depth insights on all the static stability derivatives, the airplane aerodynamics, and the propulsive effects will be given. In the second part the course will provide the knowledge to understand flight maneuvers and to predict the behavior of the airplane from the flight loads.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student shall prove to have achieved an adequate knowledge of the theory treating the maneuvers and the static stability of an airplane.

Applying knowledge and understanding

The student shall prove to be able to apply the acquired concepts by numerically evaluating the equilibrium and the static stability of airplanes in both the longitudinal and the lateral-directional plane.

COURSE CONTENT/SYLLABUS

*[3 CFU] **Equilibrium and static stability**:*
Reference frames and recap of Aerodynamics.
Outline on the equations of motion.
Concepts of airplane equilibrium and stability.
Longitudinal equilibrium and stability – stick-fixed and stick-free neutral point.
Lateral-directional equilibrium and stability.
Longitudinal and lateral-directional static stability derivatives and their evaluation.
Direct and indirect propulsive effects (propeller and jet).

*[3 CFU] **Maneuvers**:*
Control powers of movables.
Unsteady and dynamic derivatives.
Maneuvers in the longitudinal plane (steady straight and level flight, steady climb, pull-up)
Maneuvers in the lateral-directional plane (turning flight, steady roll).
Control surface loads (stabilator, elevator, ailerons, rudder).

READINGS/BIBLIOGRAPHY

Course notes provided by the teacher.

Suggested texts:
Jan Roskam. Airplane Flight Dynamics and Automatic Flight Controls, Part 1. DARcorporation, 1995. ISBN: 1884885179, 9781884885174.

Courtland D. Perkins, Robert E. Hage. Airplane Performance, Stability and Control. Wiley, 1949.
ISBN: 9780471680468, 047168046X.

TEACHING METHODS

Lezioni sulla teoria e sviluppo in aula di una buona quantità di esercizi ed applicazioni.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	
only written	X
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)		
	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

(*) multiple options are possible

b) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the outcome of the written test.
The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

AEROSPACE SYSTEMS II

SSD ING-IND/05

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Calculus II, Geometry and Algebra, General Physics

PREREQUISITES (IF APPLICABLE)

Basic knowledge of mathematics and general physics.

LEARNING GOALS

The course aims to provide the essential elements for mathematical-physical modeling and study of problems of astrodynamics and of attitude stabilization of aerospace systems. Some classical operating conditions are studied in detail, with particular reference to space applications, with the aim of enabling the student to master, at a first level of study, the basic theoretical problems that lead to the definition of a space mission in terms of orbit and attitude.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate that he/she has achieved adequate knowledge of the theoretical formulations that allow the study of the orbital dynamics and the attitude of space systems.

Applying knowledge and understanding

The student must demonstrate that he/she is able to apply the concepts acquired for the mission analysis of a space system in terms of orbit and attitude.

COURSE CONTENT/SYLLABUS

[2 CFU] Elements of astrodynamics: reference systems, time measurement systems, n-body problem, two-body problem, mechanical energy, Kepler's laws and conic orbits, trajectory equation in the plane and in space, Kepler's equation.

[1 CFU] Elements of attitude dynamics: reference systems, rotational kinetic energy, Euler equations, Euler angles, definition of attitude and transformation matrices, kinematic equations of attitude.

[2 CFU] Linearized models for stabilized satellites on three axes. Application to the study of the attitude of free satellites, axial symmetrical and not, stability conditions of the attitude motion. Modeling of the disturbance torques on the attitude caused by the aerodynamic drag and the gravity gradient, equilibrium conditions and stability analysis of the attitude for satellites stabilized on three axes based on the exploitation of the gravity gradient in circular and elliptical orbits.

[1 CFU] Dynamics of gyroscopes, gyroscopic stationary precession and spin stabilization. Nutation damping and dual spin stabilization.

READINGS/BIBLIOGRAPHY

Course notes available on the teacher web site.

Further reading: Bate, R.R., Mueller, D.D., e White, J.E., Fundamentals of astrodynamics, 1971; Chobotov, V.A., Spacecraft attitude dynamics and control, 1991, Krieger; Kaplan, M.H., Modern spacecraft dynamics & control, 1976, John Wiley & Sons; Thomson, W.T., Introduction to space dynamics, 1986, Dover; Wertz, J.R., ed., Spacecraft attitude determination and control, 1980, D. Reidel.

TEACHING METHODS

Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA

f) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) multiple options are possible

g) Evaluation pattern:

The grade is formulated by the Examination Commission based on the outcome of the written test and the adequacy of the answers provided by the student to the questions asked during the oral test.
The final grade is also suitably motivated to the student.

COURSE DETAILS

AEROSPACE STRUCTURES

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: II
SEMESTER: II
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Mathematical Physics

PREREQUISITES

Basic knowledge of mathematics, analytic geometry, physics, and moments of inertia.

LEARNING GOALS

The course presents the basics of the theory of elasticity for the aerospace structures. At the end of the course, students should be able to: (i) to verify the stress in frames and trusses; (ii) design, with a given safety margin, structural assemblies built by one-dimensional elements; (iii) verify the shear flows of thin-walled open and closed cross-sections.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

Students should achieve adequate knowledge of the theoretical formulations that allow the sizing of aerospace structures.

Applying knowledge and understanding

Students should demonstrate that he is able to apply the concepts, learned in the study of the theory of elasticity, for the correct design of one-dimensional structural elements.

COURSE CONTENT/SYLLABUS

[2 CFU] Stress in structures. Displacements and strains. Theory of elasticity. Von Mises stress criterion.

[2,5 CFU] St. Venants's principle. Engineering theory of straight and long beams. Bending and extensional stresses in beams. Bending and extensional displacements in beams. Uniform torsion. Beam shearing stresses due to shearing forces.

[2 CFU] Stress diagrams in isostatic and hyperstatic straight long beams. Thermal distortions, elastic and inelastic subsidence-deformation.

[2 CFU] Energy theorems for solving isostatic and hyperstatic frames.

[0,5 CFU] Open and closed thin-walled sections under multi-axial loads.

READINGS/BIBLIOGRAPHY

<u>Theory</u>

Course Notes by Prof. E. Ferrante (mandatory).

Course Notes (Title: "Lezioni di Scienza delle Costruzioni") by Prof. C. Franciosi (suggested).

Bruce K. Donaldson, Analysis of Aircraft Structures, An Introduction, 2nd Edition, Cambridge Aerospace Series, 2013, ISBN: 9781107668669 (suggested).

Exercises
Course Notes by Prof. E. Ferrante.
Collection of examination themes, presented during the course.

TEACHING METHODS

Lectures and exercises, requiring pocket calculators, for applying and learning the theoretic formulations. Multimedia material as auxiliary tool.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	
only written	X
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) È possibile rispondere a più opzioni

b) Evaluation pattern:

Each exercise of the written exam has a score. The final grade is formulated by the Examination Committee according to the scores achieved by the student in the written exam.
The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

AEROSPACE CONSTRUCTIONS I

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION - ACTIVITIES

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 9

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Strutture Aerospaziali

PREREQUISITES

-

LEARNING GOALS

The course aims to deliver theoretical and practical tools for solving structural problems by calculating the stress state mainly in shell structures, calculating the stability of the elastic equilibrium as well as post-buckling behaviour. Critical load conditions are analyzed as per CS-23 and CS-25 regulations. Finally, the principles of fatigue, static aeroelasticity and composite materials design and analysis are introduced.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student will have to demonstrate that he has achieved an adequate knowledge of the structural design methods of shell structures used in aerospace engineering.

Applying knowledge and understanding

The student will have to demonstrate that he is able to determine and calculate the stress state in shell structures, in the use of aerospace engineering, to guide the design according to CS-23 and CS-25.

COURSE CONTENT/SYLLABUS

[1 CFU] INTRODUCTION TO AERONAUTICAL STRUCTURES: structural types of wings, tail planes, fuselages.

[1 CFU] ENERGY METHODS: principle of virtual works, Resolution of hyperstatic beams, resolution of force fuselage frame.

[1 CFU] THIN PLATES SMALL DISPLACEMENTS: Kirchhoff plate, Determination of the equation of the elastic plane, effect of the loads in the plane.

[3 CFU] INSTABILITY OF BEAMS AND PLATES: Introduction to the instability of the beam with energy methods and Euler Johnson's theory, Rayleigh Ritz method. Non linear instability and tangent modulus. Plate instability, analytical treatment. Instability of thin-walled structures, case of open section beams, difference between buckling and cripling, Johnson's rule, Nedham's angle rule. Effect of compression in the choice of materials, non-elastic buckling, effect of surface treatments, choice of materials in a typical aeronautical case. Combined effects: multiaxial loads, curved panels, stiffened panels (practical shell and SEC in post buckling) Diagonal tension: conceptual treatment, NACA method, alternative method.

[1 CFU] CALCULATION OF SHEAR FLOWS: Definition of practical shell and structure with SEC concentrated elements (limits and approximation, effect of constraints). Torsion absorption in a SEC structure (case 4 caps and 4 webs).

[1 CFU] LOADS, MANOUVRE AND GUST DIAGRAMS

[1 CFU] INTRODUCTION TO COMPOSITE MATERIALS. NOTES OF AEROELASTICITY AND FATIGUE

READINGS/BIBLIOGRAPHY

T.H. Megson, Aircraft structures for Engineering Students – Edward Arnold.
S. Timoshenko and J.M. Gere, Theory of Elastic stability, - McGraw Hill.
M.C.-Y. Niu, Airframe Stress Analysis and Sizing, Conmlit Press LTD 1999.
Notes of the course.

TEACHING METHODS

Theoretical lessons, numerical exercises with case studies.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)		
	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

(*) Several options are allowed

b) Evaluation pattern:

The grade is formulated by the Examination Committee on the basis of the adequacy of the answers provided by the student to the questions that have been formulated in the oral test and on the basis of a written test that involves the resolution of some numerical problems.
The final grade is also suitably motivated to the student.

COURSE DETAILS

GENERAL PHYSICS II

SSD FIS/01

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: **PROF. MASSIMO DELLA PIETRA**
PHONE: **081676277**
EMAIL: **MASSIMO.DELLAPIETRA@UNINA.IT**

GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: ELETTROMAGNETISMO E ELETTROTECNICA
MODULE: GENERAL PHYSICS II

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

General Physics I

PREREQUISITES (IF APPLICABLE)

Reasonable knowledge of the contents of the courses of Mathematical Analysis and Algebra and Geometry

LEARNING GOALS

The course aims to provide students with the basic notions and concepts of electromagnetism in vacuum and the introduction of the concept of electromagnetic wave, as well as some hints on electrical and magnetic phenomena in homogeneous and isotropic material media. The phenomenological and methodological aspects will be privileged. Students will also acquire a conscious operational ability in solving numerical exercises.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate to know and be able to understand the theoretical and experimental foundations of electrical and magnetic phenomena in vacuum and in matter and provide the interpretation of these phenomena through the concepts of electric charge, electric field and potential, magnetic field and electric current. Finally, the student must be able to understand the physical-mathematical conceptual schemes and tools necessary for learning scientific knowledge in general and to successfully tackle subsequent courses in physics, applied physics and engineering.

Applying knowledge and understanding

At the end of the course the student must demonstrate that he has acquired the ability to apply the knowledge learned to solve in a quantitative way relatively simple problems concerning electrical or magnetic phenomena such as electrical conduction, the calculation of the electric and magnetic field in space and the calculation of forces of interaction between electric charges or between current-carrying wires and external magnetic fields. The training course is aimed at transmitting the ability to select the known information of a problem and to introduce the appropriate schematizations and simplifications for its solution.

COURSE CONTENT/SYLLABUS

Coulomb's and Gauss' laws; Electrostatics in vacuum; Electrostatic energy; Dielectric materials; Metals and electric conduction; Steady-state magnetism in vacuum; Electromagnetic induction; Time varying fields and Maxwell equations; The wave equation and the electromagnetic waves. Principles of Optics.

READINGS/BIBLIOGRAPHY

P. Mazzoldi, M. Nigro, C. Voci, Elementi di Fisica (Elettromagnetismo, Onde), EdiSES
P.A. Tipler, G. Mosca, Corso di Fisica vol. 2° (Elettricità, Magnetismo, Ottica), Zanichelli Editore;
D, Halliday, R. Resnick, J. Walker, Fondamenti di Fisica (Meccanica, Termologia, Elettrologia, Magnetismo, Ottica), Casa Editrice Ambrosiana;
R.A. Serway e J.W. Jewett, Fisica, vol. 2 (Elettromagnetismo), EdiSES
W.E. Gettys, F.J. Keller, M.J. Skove, Fisica 2 (Elettromagnetismo-Onde), McGraw-Hill

TEACHING METHODS

The teacher will dedicate about 2/3 of the total hours of the course to lectures and the remaining time will be dedicated to numerical exercises.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

COURSE DETAILS

NUMERICAL METHODS IN AEROSPACE ENGINEERING

SSD ING-IND/06

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

Elementi di Informatica, Aerodinamica, Gasdinamica

PREREQUISITES

LEARNING GOALS

The course aims to provide the student with the fundamentals of numerical methods for the solution of typical problems arising in aerospace engineering. In particular, models governed by ordinary or partial differential equations that are typically encountered in mathematical physics and engineering will be considered. The student will also be provided with operational competence in the production of numerical codes. During the course, the theoretical concepts introduced will be used to write numerical codes implementing the techniques illustrated.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student should achieve adequate knowledge of the principal numerical methods used to solve problems in mathematical physics and engineering.

Applying knowledge and understanding

The student should demonstrate to be able to apply the numerical methodologies studied by developing numerical codes for the solution of specific problems governed by algebraic or differential equations.

COURSE CONTENT/SYLLABUS

[1.5 CFU] Fundamentals of scientific computing and MATLAB programming. Basics of Linear Algebra. One-dimensional Lagrangian interpolation theory. Elements of Hermitian and Spline interpolation theories.

[3 CFU] Theory of numerical differentiation. The Finite-Difference method for partial differential equations. Applications to model differential equations describing steady and unsteady convection-diffusion transport phenomena.

[1.5 CFU] Methods for the numerical solution of ordinary differential equations. Writing of numerical codes for the simulation of 1D and 2D spatial-temporal phenomenologies and comparison with analytical solutions.

READINGS/BIBLIOGRAPHY

R. J. LeVeque. Finite Difference Methods for Ordinary and Partial Differential Equations: Steady State and Time Dependent Problems. SIAM (2007).
D. Griffiths, D. J. Higham. Numerical Methods for Ordinary Differential Equations: Initial Value Problems. Springer (2010).
Notes from the lectures. Numerical codes written during the exercise lessons.

TEACHING METHODS

Theoretical lectures, computer applications illustrated by the teacher and practical exercises carried out by the students in the laboratories.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	X

(*) È possibile rispondere a più opzioni

b) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the scores achieved by the student in the practical exercise and to the answers to the theoretical exam. The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

AEROSPACE MATERIALS TECHNOLOGIES

SSD ING-IND/16

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Chimica

LEARNING GOALS

The course aims to provide students with both an understanding of the potential and applications of the most innovative processing technologies in the aerospace field, and the engineering tools necessary for designing production processes with these technologies. It also aims to train a professional figure capable of being able to adequately address the problems and aspects related to the sector of innovative technologies.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student will have to demonstrate that they have achieved an adequate knowledge of composite materials and design criteria, as well as of the processing technologies most used in aerospace engineering and the engineering tools necessary for the design of processes.

Applying knowledge and understanding

The student will have to demonstrate to be able to analyze the essential parameters of the production processes used in aerospace engineering and to know how to design them.

COURSE CONTENT/SYLLABUS

[0,5 CFU] Composite materials in the aerospace field: definition, structure, advantages and applications. Fibers, matrix, the concept of interphase and interface, single layers, laminates.

[1 CFU] Micromechanics of composite materials: mean law, reference systems, the constitutive bond, stiffness and compliance matrix.
Macromechanics of composite materials, Theory of lamination.

[1 CFU] Mechanical characterization tests for composite materials: tensile test, compression test, bending test (three and four points), interlaminar shear test, intralaminar shear test.

[1 CFU] Manufacturing technologies of composite laminates and structures: hand lay up, cutting and spray lay up, autoclave bag moulding, wrapping, pultrusion and compression molding.

[1 CFU] Defects of parts in composite material. Non-destructive tests for parts made by composite material: ultrasound, radiography, thermal and acoustic emission.

[1 CFU] Titanium alloys as high-performance metals for aerospace use and their affinity with composite materials. Innovative technologies in the aerospace sector. Superplastic forming: mechanical aspects and processing technologies. Introduction to heat treatments.

[0,5 CFU] Cold Gas Dynamic Spray cold technology. Metal foams: production technologies, advantages and possible applications

READINGS/BIBLIOGRAPHY
The teaching material is available entirely on the University teachers website. The same site also contains the references of the texts recommended to deepen the topics covered.

TEACHING METHODS
The course includes in addition to lectures, practical exercises in the laboratory in which students are shown the main stages of fabricating a component in composite material, as well as the main mechanical tests.

EXAMINATION/EVALUATION CRITERIA

h) Exam type:

Type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to:	**Multiple choice answers**	X
	Open answers	X
	Numerical exercises	X

i) Score:
The written test is associated to a score to be integrated with the oral test. The grade is formulated by the Committee on the basis of the score achieved by the student in carrying out the test. The final score is also suitably motivated to the student.

COURSE DETAILS

ELECTROTECHNICS

SSD ING-IND/31

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

Fuorigrotta

TEACHER: CARLO FORESTIERE
PHONE: 0817682007
EMAIL: CARLO.FORESTIERE@UNINA.IT

San Giovanni

TEACHER: ANTONIO QUERCIA
EMAIL: ANTONIO.QUERCIA@UNINA.IT

GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE: ELETTROMAGNETISMO E ELETTROTECNICA
MODULE: ELETTROTECNICA

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Analisi Matematica I

PREREQUISITES (IF APPLICABLE)

-

LEARNING GOALS

The aim of this course is to provide students with the basic notions of the theory of circuits in stationary, sinusoidal and periodic steady-state and of linear dynamic circuits of the first and second order; to systematically introduce the general properties of the circuit model, the main theorems, and the main methods of analysis.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

This course provides students with the knowledge and basic methodological tools necessary to analyze linear circuits, in stationary, sinusoidal, and periodic steady-state, and to analyze linear dynamic circuits of the first order. The student will be able to recognize the limits of validity and the main implications of the basic theorems of circuits. The student will be able to understand the basic application of electrical engineering.

Applying knowledge and understanding

The student needs to show the ability to solve linear circuits, in stationary, sinusoidal, and periodic steady-state operation; to solve linear dynamic circuits of the first order; to identify the most appropriate solution method; and to use where necessary the main circuit theorems. The student needs to show to master the basic concepts of circuit theory, and its elementary applications, and to derive the main theorems correctly using the jargon.

COURSE CONTENT/SYLLABUS

1. THE LAWS OF ELECTROMAGNETISM

Electric charge, electric current, current density. Electric field, magnetic field, Lorentz force. The laws of electromagnetism in vacuum in integral form. Law of charge conservation. The laws of electromagnetism in matter in integral form. Work of the electric field, energy stored in the electric field, energy stored in the magnetic field, electric power, electric energy. Units of measure.

2. THE CIRCUIT MODEL

Electric circuits in slowly changing conditions. Two-terminal element: intensity of electric current, electric voltage, electric power, electric energy. Reference Directions. Passive/active sign convention. Kirchhoff's laws. Canonical two-terminal elements: resistor, switch, independent generators, capacitor, inductor. Real generators. Active, passive, dissipative, and conservative Two-terminal element. Frequency limits of the circuit model.

3. CIRCUIT EQUATIONS

Simple resistive circuit; non-linear resistive circuit and graphical solution method; {Newton Raphson's algorithm}; linear dynamic circuits of the first order, stationary and sinusoidal steady state. Circuit graph, digraph, subgraph. Connected graph, loop, tree, co-tree, cut set; planar graphs and rings; fundamental loop set {and fundamental cut set}; incidence matrix and reduced incidence matrix, {loop matrix and reduced loop *matrix}, Kirchhoff equations in matrix form, independent Kirchhoff's voltage equations, independent Kirchhoff's current equations, the system of fundamental equations. Node analysis;. Tableau analysis. Conservation of virtual powers (Tellegen's theorem); conservation of electrical powers.*

4. GENERAL RESISTIVE CIRCUITS
Equivalent transformation of electric circuits, series and parallel connections of resistors; voltage and current divider rules, series and parallel of ideal generators and pathological cases, equivalence transformation of real generators; linear resistive circuits, superimposition principle; equivalent Thevénin-Norton generator; No-voltage gain property {No-current gain property}. Y-Δ transform.

5. MULTI-TERMINAL AND MULTI-PORTS CIRCUIT ELEMENTS
N-poles, descriptive currents, and voltages. Two-ports: absorbed electrical power; linear controlled voltage and current sources, ideal transformer; gyrator. Resistive two-ports, reciprocity theorem, resistance matrix, conductance matrix, T and π configurations. Mutually coupled circuits (transformer), characteristic relations, perfect coupling, equivalent circuits

6. CIRCUITS IN STEADY-STATE
Steady-state analysis. Sinusoidal steady-state analysis. Phasors, symbolic method; complex numbers. Impedance, impedance circuits, properties of impedance circuits. Instantaneous power, complex power, average power, reactive power. Phasor diagrams of elementary two-terminal elements. Conservation of complex power, average power and reactive power. Impedance two-terminal elements; analysis in periodic regime. Averaged power due to several sinusoidal inputs. Resonant circuit, quality factor, power and energy balances. Three-phase systems, star center displacement and Millman formula, power measurement and Aron insertion.

7. LINEAR DYNAMIC CIRCUITS
State equations and state variables of first order circuits, State equations and state variables of second order circuits, associated resistive circuit. Continuity of state variables; solution of first order circuits. Free evolution, forced evolution, natural modes of evolution, natural frequency, time constant, transient term, permanent term, dissipative circuit, time-varying circuit.

8. APPLICATIONS
Mutually coupled circuits (transformer), characteristic relations, perfect coupling, equivalent circuits. Condition of physical realizability and perfect coupling. Equivalent circuits. Losses in iron and copper and equivalent circuit of the real transformer (outline). Notes on systems for electricity distribution. Electrical systems and their classification. Electrical safety. Electrocution. Direct and indirect contacts. The electrical ground system. Differential switch. General information on electromechanical conversion. The asynchronous machine. The rotating magnetic field. Stator and rotor.

READINGS/BIBLIOGRAPHY

Main Textbook

M. de Magistris, G. Miano, Circuiti, II edizione, SPRINGER, settembre 2009.

Additional References

[1] L.O. Chua, C.A. Desoer, E.S. Kuh, Circuiti Lineari E Non Lineari, Jackson, 1991.

[2] G. Miano, Lezioni Di Elettrotecnica, Ed. Cuen, 1998;
[3] L. De Menna, Elettrotecnica, Ed. Pironti, Napoli, 1998.
[4] I.D. Mayergoyz, W. Lawson, Elementi Di Teoria Dei Circuiti, Utet, 2000.
[5] H. A. Haus, J.R. Melcher, "Electromagnetic Fields And Energy," Prentice Hall, 1989

Exercises

[1] S. Bobbio, L. De Menna, G. Miano, L. Verolino, Quaderno N ° 1: Circuiti In Regime Stazionario, Ed. Cuen, Napoli, 1998.
[2] " " Quaderno N ° 2: Circuiti In Regime Sinusoidale, Ed. Cuen, Napoli, 1998.
[3] " " Quaderno N ° 3: Circuiti In Evoluzione Dinamica: Analisi Nel Dominio Del Tempo Ed. Cuen, Napoli, 1998.
[4] S. Bobbio, Esercizi Di Elettrotecnica, Ed. Cuen, Napoli, 1995.

Mooc
Mooc available on https://www.federica.eu/

TEACHING METHODS
Lectures for approx. 60% of total hours; practical exercises for approx. 40 % of total hours

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	x
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	X

COURSE DETAILS

PROBABILITY AND STATISTICS

SSD SECS-S/02

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)
Mathematical Analysis I

PREREQUISITES
Basic knowledge of mathematics.

LEARNING GOALS
The course provides the students with fundamentals of probability calculus, analysis of data, and inferential statistical procedures as well as with their use in the engineering field. On successful completion of the course, the students will be able to use statistical method to analyze and control non-deterministic phenomena, with special focus on aerospace applications.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
Students should achieve adequate theoretical knowledge of the calculation of probabilities and data analysis.

Applying knowledge and understanding
Students should demonstrate that he is able to apply probabilistic and statistical models and methods to formalize and solve practical problems of aerospace interest.

COURSE CONTENT/SYLLABUS
[2 CFU] Element of Set Theory, Combinatorial analysis. Definitions of probability and calculation criteria. Conditional probability. Stochastic Independence. Total probability law. Bayes theorem. Applications in scientific and technological field .Random variables. Probability distributions. Mean, variance, and covariance.

[1.5 CFU] Models of random variables: Bernoulli, binomial, geometric, negative binomial, hypergeometric, Poisson, uniform, exponential, gamma, normal. Central limit theorem. Transformation of random variables. Moment generating function. Models used in inferential statistics: chi square, and student’s t., and Fisher’s F.

[2.5 CFU] Experimental study of random variables. Empirical distribution. Graphical representation. Sampling distributions. Point estimation: method of moments and maximum likelihood method. Interval estimation Hypothesis testing: null hypothesis, alternative hypothesis, type I error, type II error, level of significance, and power of test. Test on parameters of a single population. Goodness of fit tests. Student's t-test for comparing the means of two populations. Fisher F-test for comparing the variances of two populations.

READINGS/BIBLIOGRAPHY
P. Erto, Probabilità e statistica per le scienze e l’ingegneria. McGraw-Hill, 3° ed.
Other recommended books: S. M. Ross, Probabilità e statistica per l’ingegneria e le scienze, Apogeo.

TEACHING METHODS
Lectures, tutorials, and seminars

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	
only written	X
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) È possibile rispondere a più opzioni

b) Evaluation pattern:

The grade is formulated by the Examination Commission based on the outcome of the written test and the adequacy of the answers provided by the student to the questions asked during the oral test.

The elements that have been taken into consideration to determine the final grade are illustrated to the student.

COURSE DETAILS

AEROSPACE PROPULSION

SSD ING-IND/07

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: II
CFU: 9

REQUIRED PRELIMINARY COURSES

Chemistry, Aerodynamics, Gasdynamics

LEARNING GOALS

The course aims to introduce the student to the main configurations of the propulsion systems currently used in the aerospace field and the methodologies to be used to evaluate the main propulsion parameters. The basic concepts, principles of operation, criteria and fields of use, performance analysis, development, implementation and integration of aeronautical and space propulsion systems and their components are provided, the analysis of the chemical-physical processes underlying their operation

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must demonstrate knowledge and understanding of the theoretical foundations and the physical and chemical principles underlying the operation of the main aerospace propulsion systems, with particular reference to those used in the aeronautical field. He must also acquire the ability to: 1) analyze the thermodynamic cycle of a thermal engine; 2) apply basic principles of one-dimensional aero-thermodynamics, in order to understand the functioning of different aerospace propulsion systems; 3) know the main configurations of airbreathing engines and endoreactors currently used and proposed for the future, with particular reference to the methodologies to evaluate the most important propulsion parameters. Finally, the student must be able to apply the conceptual schemes and tools acquired in the previous courses of Chemistry, Aerodynamics and Gasdynamics to understand the physical principles and methodologies necessary for the design of aerospace thrusters and their components such as turbomachinery.

Applying knowledge and understanding

At the end of the course the student must demonstrate that he has acquired the ability to apply the knowledge learned to quantitatively solve classical problems in the field of aerospace propulsion.

COURSE CONTENT/SYLLABUS

(1 cfu) General information on Aerospace Propulsion. Classification of aerospace propulsion systems. Configurations of aeronautical engines. Main propulsive parameters.

(2 credits) Brayton-Joule cycle. Gas turbine. Thermal and adiabatic efficiency. Simple turbojet with afterburner. Dual flow turbojets (turbofan). Ramjet and Scramjet statoreactors.

(1 cfu) Propeller engines. Turboprops.

(1 cfu) Combustion process. Enthalpy of formation and heat of reaction. Mixing ratio. Chemical equilibrium conditions. Combustion chambers. Injectors.

(1 cfu) Fluid dynamics of turbomachinery: the compressor, Euler's theorem of turbomachinery, the turbine. Compressor diagram.

(1 cfu) Fluid dynamics of air intakes and nozzles: Different types of air intakes: divergent inlet, central spike intake. Operation of air intakes outside nominal design conditions.

(1 cfu) Nozzles: simply convergent, convergent with variable exit section, convergent-divergent, unconventional nozzles.

(1 cfu) Notes on access to space and space transportation systems, conventional and unconventional space rockets.

READINGS/BIBLIOGRAPHY

Notes and slides of the course. Students are also provided with photocopies of data and graphs useful for exercise purposes.

Main Textbook

Brian J. Cantwel, Aircraft and Rocket Propulsion, Department of Aeronautics and Astronautics, Stanford University (2010).
Farokhi, Aircraft Propulsion Wiley, 2 ed. (2014).
Mattingly and Boye, Elements of Propulsion: Gas Turbines and Rockets, AIAA, 2 ed.
Flack, Fundamentals of Jet Propulsion with Applications, CUP, (2010).
Kerrebrock, Aircraft engines and gas turbines, MIT, (1992).
Hill, Mechanics And Thermodynamics of Propulsion, Pearson India; 2 ed (2009).
Sforza, Theory of Aerospace Propulsion BH, 2 ed (2016).
Rolls Royce, The Jet Engine, Wiley, 2015.

TEACHING METHODS

The teacher will dedicate about 2/3 of the total hours of the course for lectures and the remaining part will be dedicated to numerical applications.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	
only written	
only oral	X
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	

b) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the responses given the student in during the oral exam.

The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

COMPLEMENTS OF AEROSPACE CONSTRUCTIONS

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION - ACTIVITIES

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 3

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")
-

PREREQUISITES
-

LEARING GOALS
The objective of the course is to provide to students the fundamental elements of structural analysis, with particular reference to a calculation method called "Matricial Method" applied to the analysis of simple structures. The course also intends to build the foundations for structural analysis using numerical techniques in a linear and static context (Finite Element Method). At the end of the course the student will be able to model simple structures using the finite element technique; in particular, he will be able to choose the type of finite elements with the most suitable formulation to represent the structure under study as well as the correct representation of the boundary conditions and the attribution of the mechanical characteristics of the materials. Finally, the student will be able to correctly interpret the structural behavior of generic structures, to propose an appropriate numerical modeling and to use software for structural analysis.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The students will have to demonstrate that they have achieved adequate knowledge on numerical simulation methodologies for solving static problems of aerospace structures.

Applying knowledge and understanding
The student will have to demonstrate to be independently able to apply the calculation methodologies, using commercial software, for the resolution of static problems of aerospace structures.

COURSE CONTENT/SYLLABUS

[1 CFU] Introduction to Finite Element Method and to Matricial Method.

[1 CFU] Spring element and resolution of spring systems

[1 CFU] Rod element and resolution of reticular structures

[1 CFU] Beam element and resolution of frame structures

[1 CFU] Two-dimensional elements

[1 CFU] Practical considerations on modeling trough Finite Element Analysis Software

READINGS/BIBLIOGRAPHY
Notes and slides of the course.

J.N. Reddy, Introduction to Finite Element Analysis - Mc Graw Hill.
T.H. Megson, Aircraft structures for Engineering Students – Edward Arnold.

TEACHING METHODS

Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	
only written	X
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) Multiple options can be answered

b) Evaluation pattern:

The mark is formulated by the Examination Commission based on the outcome of the written test: an explicit score is associated with the different questions.
The final grade is also suitably motivated to the student.

COURSE DETAILS

LABORATORY FOR CALCULATION OF STRUCTURES

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION - ACTIVITIES

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 3

Interruzione pagina

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Strutture Aerospaziali

PREREQUISITES

-

LEARING GOALS

The course is an introduction to the computational mechanics of solids and structures. The course deals with the description and modeling of the static properties of structures by applying the finite element method, in linear regime, to the solution of aerospace engineering problems in the structural field. The aim of the course is to provide students the fundamental concepts and operational tools to solve current structural problems using information technology.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The project work is a training activity that allows the students to gain knowledge by requiring them to work for an extent period of time to investigate a complex problem or question. During project work students are given the freedom and opportunity to explore real engineerng problems and develop a deeper and more enriched understanding. The student must develop a solution to the design problem that is posed (or proposed), also investigating different alternatives and confronting himself with theoretical and / or experimental references. This will give to the student the opportunity to apply, pratically, methods and techniques, acquired theoretically in other courses.

Applying knowledge and understanding
The student must demonstrate that he has achieved adequate knowledge on numerical simulation methodologies for solving static problems of aerospace structures and must demonstrate that he is able to independently apply the calculation methodologies, using numerical tools, for the resolution of problems of statics of aerospace structures.

COURSE CONTENT/SYLLABUS

[1 CFU]
Introduction to numerical methods for structural analysis.
Finite Element Methods: introduction and applications.

[1 CFU]
Mathematical model, domain discretization, derivation of Finite Element Equations, selection of element type, assembly of the global stiffness matrix, selection and application of loads and boundary conditions, solutions.
Analysis of simple one-two-three dimensional structures.

[1 CFU]
Finite element modeling and analysis of complex one-two-three dimensional structures.
Finite element modeling and analysis of some typical aeronautic structures.

READINGS/BIBLIOGRAPHY
Courses notes by prof. G. Petrone (mandatory).
J.N. Reddy, Introduction to Finite Element Analysis - Mc Graw Hill (suggested).
T.H. Megson, Aircraft structures for Engineering Students – Edward Arnold (suggested).

TEACHING METHODS
Lectures and exercises.

EXAMINATION/EVALUATION CRITERIA

a. **Exam type:**

Exam type	
written and oral	
only written	
only oral	
project discussion	X
other	

In case of a written exam, questions refer to: (*)	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

(*) Multiple options can be answered

a. **Evaluation pattern:**

The mark is formulated by the Examination Commission on the basis of the quality and completeness of the project work, the relevance of the topic with respect to the course objectives and the quality of the candidate's presentation as well as his/her ability to present the project and to reply to the questions about the course programme.

COURSE DETAILS

ON-BOARD SYSTEMS LABORATORY

SSD ING-IND/05

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION ABOUT THE COURSE

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

Sistemi Aerospaziali

PREREQUISITES

-

LEARNING GOALS

The course's goal is twofold. On the one side, it aims to provide fundamentals about HW and SW used in the development of onboard systems. On the other side, it has a strong practical imprint as it aims at providing the students with confidence and learning-by-doing experience on embedded systems for acquisition and processing of data from sensors and/or for the implementation of advanced functions. So, this course is preparatory to a professional usage of such technologies by an aerospace systems engineer.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student shall prove an adequate understanding about HW and SW components used for onboard aerospace systems.

Applying knowledge and understanding

The student shall prove capability to analyze and process data from sensors on board of an aerospace platform and to implement advanced functions.

COURSE CONTENT/SYLLABUS

[3 CFU] ***Theoretical fundamentals***

Onboard systems architectures, embedded systems, real-time systems, scheduling of tasks for real-time operating systems, timing of data acquired in real time. Basics on active and passive electro-optical sensors, camera models (e.g., pinhole, plumb bob model), camera calibration, basics of stereo-camera systems (triangulation, disparity, uncertainty), basics and taxonomy of LIDAR systems, LIDAR equation, basics on inertial sensors and magnetometers, inertial sensors calibration.

[3 CFU] ***Practical part***

Development of processing capability using data acquired by onboard sensors (monocular and stereo cameras, LIDAR, inertial sensors, magnetometers, GNSS receivers) for aeronautical and space applications by means of standard and interactive exercise sessions. Applicative case studies: detection and tracking of fixed/moving obstacles, georeferencing from images, inertial navigation initialization, visual and LIDAR odometry, pose determination for autonomous navigation.

READINGS/BIBLIOGRAPHY

Lectures slides.
Scientific articles and books suggested by the teacher
Tutorial online.

TEACHING METHODS

Lectures and exercises, teamwork, use of specific SW.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	
only written	
only oral	X
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	X
	Numerical exercises	X

(*) È possibile rispondere a più opzioni

b) Evaluation pattern:

The score is formulated by the Examination Committee based on the adequacy of answers provided by the student to the received questions. The score is also properly motivated to the student.

COURSE DETAILS

AIRCRAFT MAINTENANCE

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION - ACTIVITIES

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: II
CFU: 3

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)
-

PREREQUISITES
-

LEARNING GOALS
The course provides all the notions useful to fully cover the contents of modules 7 (Maintenance Practices) and 9 (Human Factors) of the syllabus required by the aeronautical rules (EASA Part 66 / AER.P-66) useful for obtaining the License Aviation Maintenance (LMA) / Military Aircraft Maintenance License (MAML).
Specifically: a) to involve students in issues relating to the Technical Management of Aircraft used in public transport, aimed at "Continuous Airworthiness", as a completion of the "virtuous circle" which includes Design and Structures; b) outline the central role of Engineering in the Air Operator and Aeronautical Maintenance Companies, indicating possible career opportunities for young engineers; c) acquire awareness of the maintenance needs of an aircraft or aeronautical item as well as the necessary basic knowledge underlying the supervision of more or less complex maintenance activities both in technical and management terms, paying particular attention to risk-assessment theories, management of areas of work, socio-psycho-physiological limits of maintenance technicians and in general the Human Factor in maintenance processes of aeronautical systems.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The student must show that he/she has achieved adequate knowledge of maintenance practices and related human factors.

Applying knowledge and understanding
The student must demonstrate to be able to apply the knowledge to the technical management of aircraft and to all the essential aspects useful for obtaining the Aeronautical Maintenance License.

COURSE CONTENT/SYLLABUS

[1 CFU] Management of the aircraft, identification and control of the configuration and definition of the Maintenance concept.

[1 CFU] Aeronautical Maintenance as the main tool to guarantee the “Continuing Airworthiness” of Aircraft (maintainability requirement in the design, approval and production phase of an aeronautical item). Execution and supervision of aircraft maintenance activities and related components and equipment: safety precautions and maintenance procedures, tools and equipment, fault finding concept, avionics test equipment, engineering drawings, diagrams and standards, fits and clearances, wiring diagrams, riveting, hoses and hoses, gaskets, springs and bearings, transmissions, wiring, actuators and servomechanisms, handling of aircraft material, welding, brazing and bonding, weight and balance of the aircraft, handling, preservation of an aircraft item, disassembly, inspection, repair and assembly techniques, unexpected events, armament safety.

[1 CFU] Notes on the methods of "Risk Assessment & Risk Management". "Human Factor" in Maintenance processes: human performance and limitations, socio-psycho-physiological factors relevant to maintenance operators in the management of maintenance tasks, communication, human error, man-machine interference,

work environment, control tools. Implementation of the "Quality/Safety Management System" in the management and maintenance of aircraft.

READINGS/BIBLIOGRAPHY

Teaching material prepared by the teacher (slides) and videos for academic use.

TEACHING METHODS

Lectures with discussion and analysis of real cases.
Visit at an aeronautical company (Maintenance – Repair – Hoverhaul) and at an Air Force group/site working for maintenance of military aircraft.
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EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam Type	
written and oral	
only written	
only oral	X
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	
	Open answers	
	Numerical exercises	

(*) Several options are allowed

b) Evaluation pattern:
The final grade is formulated by the Examination Committee according to the answers given by the student during the oral discussion.
The final evaluation is discussed and highlighted to each student.

COURSE DETAILS

AERONAUTICAL REGULATIONS

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER:
PHONE:
EMAIL:

SEE DEGREE PROGRAMME WEBSITE

GENERAL INFORMATION - ACTIVITIES

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: I
CFU: 3

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

-

PREREQUISITES

-

LEARNING GOALS

The course provides all the notions useful to fully cover the contents of module 10 (Aeronautical legislation) of the syllabus approved by the Certification Agencies (EASA Part 66 and AER.P-66), useful for obtaining the Aeronautical Maintenance License (LMA) / Military Aircraft Maintenance License (MAML).

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student must show that he/she has achieved adequate knowledge of the most significant aspects of the aeronautical legislation of the civil and military sector and the main standards used by the Civil and Military Aviation Authorities as part of the certification process of companies and aeronautical products.

Applying knowledge and understanding

The student must show that he/she is able to apply the knowledge acquired by highlighting the complex correlations that exists among the various regulations; essential skills for obtaining the Aeronautical Maintenance License.

COURSE CONTENT/SYLLABUS

[1 CFU]
Unit 0: Presentation of the course and program
Unit 01: Optional regulatory environment - Family of ISO 9000 standards & Other third party regulations
Unit 02: Mandatory regulatory environment in civil and military fields - ICAO & EASA Chicago Convention and Military Airworthiness Authority
[1 CFU]
Unit 03: European Civil and Military Regulatory Environment - EASA Regulations & European Military Airworthiness Requirements (EMAR 21)
Unit 04: Certification of aircraft, parts and appliances: EC 748/2012 & EMAR 21 - Initial & Continued Airworthiness
Unit 05: Certification of Design Organizations (DOA): EC 748/2012 Part 21A-sub (J) & EMAR 21 sub (J)
Unit 06: Certification of Production Organizations (POA)EC748/2012-Part 21A-sub (F)/(G) & EMAR 21 sub (F)/(G)
[1 CFU]
Unit 07: EC 1321/2014 - Continuing airworthiness
Unit 08: EC 1321/2014 - Annex I - Part M & EMAR M (including the Liability of the Airline Operator, with particular regard to continuing airworthiness and maintenance and the Aircraft Maintenance Program)
Unit 09: EC 1321 / 2014- Annex II - Part 145 & EMAR 145
Unit 10: EC 1321/2014 Annex III - Part 66 & EMAR 66
Unit 11: Aircraft Certification- Documents

READINGS/BIBLIOGRAPHY

Slides aimed at presenting the contents of the Teaching Units in a structured and detailed way: 1 Handout for each Teaching Unit; 1 Learning Test (multiple choice) associated with each Teaching Unit and aimed at verifying learning.

TEACHING METHODS

Teaching Units distributed on Lessons of 4 hours each. Description of the issues with the help of the Slides. Learning verification test.

EXAMINATION/EVALUATION CRITERIA

c) Exam type:

Exam Type	
written and oral	X
only written	
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)		
	Multiple choice answers	
	Open answers	X
	Numerical exercises	X

(*) Several options are allowed

d) Evaluation pattern:

The grade is formulated by the Examination Commission based on the outcome of the written test and the adequacy of the answers provided by the student to the questions asked during the oral test.

The final evaluation is discussed and highlighted to each student.

COURSE DETAIL

EXPERIMENTATION OF STRUCTURES

SSD ING-IND/04

NAME OF THE COURSE: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-23

GENERAL INFORMATION - TEACHER

TEACHER: PROF. MASSIMO VISCARDI
PHONE: 081/7683327
EMAIL: MASSIMO.VISCARDI@UNINA.IT

SEE WEBSITE OF THE COURSE OF STUDY

GENERAL INFORMATION - ACTIVITIES

COURSE YEAR: III
SEMESTRE: II
CFU: 6

PREPARATORY COURSES (if required by the Regulations of the CdS)
Aerospace structures

POSSIBLE PREREQUISITES
-

TRAINING OBJECTIVES
The course is mainly applicative and provides the elements, tools and methods for the execution of experiments on structures and materials for aerospace use.
The course includes a didactic path that starting from the basic principles of experimentation, introduces to the different types of sensors and actuators, and then specializes with reference to the concepts of static experimentation, fatigue, and dynamics all referred to materials, simple elements and structures typical of the aerospace sector.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding
The student should demonstrate that he has achieved an adequate knowledge of the common methods of experimentation used for the characterization of aerospace structures.

Ability to apply knowledge and understanding
The student must demonstrate to be able to apply experimental methodologies by independently managing simple experimental set-ups.

SYLLABUS PROGRAM

[1 CFU] Data acquisition systems, displacement, deformation, load, speed and acceleration transducers.

[1 CFU] Punctual and full field techniques. Testing regulations. Analysis and interpretation of experimental data. Tests on individual elements and complex structures.

[1 CFU] Static tests and fatigue tests. Organization of a static test: load analysis, methods of application of test loads, measurement systems. Analysis of experimental measurements and formulation of a test report.

[1 CFU] Machines for full-scale tests. Non-destructive investigations.

[1 CFU] Principles of dynamic experimentation: instrumentation and measurement techniques. Laser-Doppler vibrometry.

[1 CFU] Management of a test set-up, data analysis and preparation of technical reports in accordance with the main reference standards.

TEACHING MATERIALS
Course notes edited by the teacher; appropriate bibliographic references.

TEACHING METHODS

The lessons in the classroom are accompanied by sessions in the laboratory for the direct management of the experiments by the students.

ASSESSMENT OF LEARNING AND ASSESSMENT CRITERIA

a) Examination methods:

The exam is divided into a test	
written and oral	X
only written	
oral only	
discussion of project documents	X
Others	

In case of written test the questions are (*)		
	Multiple choice	
	Free answer	
	Numerical exercises	X

(*) You can respond to multiple options

b) Evaluation methods:

The vote is formulated by the Examination Commission on the basis of the written test, the discussion of aan experiment produced by the student and the oral exam on issues addressed in the educational path.

The final grade is also appropriately motivated to the student.

COURSE DETAILS

SPECIAL TECHNOLOGIES II

SSD ING-IND/04

DEGREE PROGRAMME: AEROSPACE ENGINEERING

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

TEACHER: ANTONIO VISCUSI
PHONE: 081 7685207
EMAIL: ANTONIO.VISCUSI@UNINA.IT

SEE DEGREE PROGRAMME WEBSITE

INFORMAZIONI GENERALI - ATTIVITÀ

YEAR OF THE DEGREE PROGRAMME: III
SEMESTER: II
CFU: 3

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE “REGOLAMENTO”)

- **Tecnologie dei Materiali Aerospaziali**

PREREQUISITES

- **Basic knowledge of the mechanical behavior of the main materials used in the aerospace field**

LEARNING GOALS

The course aims to provide knowledge and skills on innovative manufacturing processes of metallic and non-metallic materials and on special processing technologies of aeronautical and space interest. The course wants to provide the engineering tools necessary for the design of manufacturing processes with particular attention to the process parameters involved. It also aims to train a professional figure capable of being able to adequately address the problems and aspects related to the sector of special technologies.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The students must demonstrate that they have achieved adequate knowledge of the main special processing technologies of aeronautical and space interest.

Applying knowledge and understanding

The students must demonstrate to be able to apply the knowledge acquired on the principles underlying the special manufacturing processes for the purpose of designing them.

COURSE CONTENT/SYLLABUS

[0.5 CFU] - Cold spray deposition technologies to functionalize metal or polymeric surfaces reinforced with fibers. Traditional processes and innovative solutions proposed in the literature.

[0.5 CFU] - Processing technologies that use the LASER beam:
The physical principles underlying the operation of lasers, systems, manufacturing processes, laser cutting.

[0.5 CFU] - Processing technologies that use high pressure fluids to process the material:
WaterJet and Abrasive WaterJet technologies. The technological systems, the components of the pumping system, the single-effect intensifier, the cutting head. The main applications.

[0.5 CFU] - The special processes for forming sheet metal for aeronautical applications. A special focus on innovative incremental forming technologies.

[0.5 CFU] - Solid state welding technologies for aerospace metal materials:
Friction Stir Welding and Linear Friction Welding processes.

[0.5 CFU] - 3D printing of metals and composites:
The principles of additive manufacturing, facilities, current advantages and limitations.

READINGS/BIBLIOGRAPHY

<u>Course notes and in-depth notes available on the teacher's website and on the MS TEAMS platform</u>

TEACHING METHODS

Lectures and seminars

EXAMINATION/EVALUATION CRITERIA

b) Exam type:

Exam Type	
written and oral	
only written	X
only oral	
project discussion	
other	

In case of a written exam, questions refer to: (*)	**Multiple choice answers**	X
	Open answers	
	Numerical exercises	X

(*) È possibile rispondere a più opzioni

c) Evaluation pattern:

The final grade is formulated by the Examination Committee according to the scores achieved by the student in the written exam.

The final evaluation is discussed and highlighted to each student.