ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA | DIPARTIMENTO
DI INGEGNERIA INDUSTRIALE

Regolamento didattico del Corso Aerospace Engineering, LM-20, sede di Forlì

INDICE

Qualora, unicamente a scopo di sintesi, nel presente Regolamento sia usata la sola forma maschile, questa è da intendersi riferita in maniera inclusiva a tutte le persone che operano nell'ambito della comunità stessa.

ART. 1 CARATTERISTICHE DEL CORSO DI STUDIO

Il Corso di studio, erogato in lingua inglese, in modalità convenzionale, è a numero programmato a livello locale, in relazione alle risorse disponibili.
Il numero di studenti iscrivibili e le modalità di svolgimento della selezione saranno resi pubblici ogni anno con il relativo bando di concorso.

ART. 2 REQUISITI PER L'ACCESSO AL CORSO

Per essere ammessi al Corso di studio occorre essere in possesso di una laurea, di un diploma universitario di durata triennale, o di altro titolo di studio conseguito all'estero, riconosciuto idoneo.

Occorre, altresì, il possesso dei seguenti requisiti curriculari:

Avere conseguito la laurea in una delle seguenti classi o possedere titolo conseguito all'estero, riconosciuto idoneo:
ex D.M. 270:
L-9, L-8, L-7, L-30, L-31, L-35, ovvero una laurea equivalente dei previgenti ordinamenti.

L'ammissione al Corso è subordinata, inoltre, al superamento della verifica dell'adeguatezza della personale preparazione effettuata da parte di una Commissione sulle conoscenze a livello universitario di base in matematica, fisica ed ingegneria. La verifica avviene mediante valutazione dei titoli e colloquio e si svolgerà secondo le modalità e le procedure indicate nel "Bando di ammissione" pubblicato nel sito di corso di studio.

Nel caso di mancato superamento della verifica è preclusa l'iscrizione al Corso.

È richiesta la conoscenza della lingua inglese di livello B2 del CEFR - Quadro Comune Europeo di riferimento per la conoscenza delle lingue.
L'accertamento avviene attraverso la documentazione da presentare in fase di candidatura nel bando di ammissione.
È richiesta, inoltre, la conoscenza della lingua italiana. Gli studenti stranieri non in possesso di questo requisito dovranno inserire nel proprio piano di studi attività finalizzate al raggiungimento del livello richiesto.

ART. 3 MODALITÀ DI SCELTA DEL CURRICULUM DEL CORSO DI STUDIO

Il Corso è articolato in curricula.

Al momento dell'iscrizione lo studente deve scegliere uno dei curricula previsti dal piano didattico. La scelta del curriculum implica l'obbligo di sostenere tutti gli esami di tutte le attività formative in esso previste.
Il Consiglio di Corso di studio valuta altresì le richieste di passaggio tra curricula.

ART. 4 PIANI DI STUDIO INDIVIDUALI

È prevista la possibilità di presentazione di piani di studio individuali con le modalità, i criteri e i termini resi noti tramite il sito del Corso.
I piani di studio individuali, approvati dal Consiglio di Corso di studio, non possono comunque prescindere dal rispetto dell'ordinamento didattico.

ART. 5 MODALITÀ DI SVOLGIMENTO DELLE ATTIVITÀ FORMATIVE E TIPOLOGIA DELLE FORME DIDATTICHE

Il piano didattico allegato indica le modalità di svolgimento delle attività formative e la relativa suddivisione in ore di didattica frontale, di esercitazioni pratiche o di tirocinio, nonché la tipologia delle forme didattiche.
Eventuali ulteriori informazioni in merito saranno rese note annualmente sul sito del Corso.

ART. 6 FREQUENZA E PROPEDEUTICITÀ

La frequenza non è obbligatoria e non sono presenti propedeuticità.

Non è permesso l'accesso agli esami se lo studente non è regolarmente iscritto al corso. Inoltre, lo studente non è autorizzato ad accedere all'esame di un corso al quale è iscritto per uno specifico anno accademico se le lezioni di tale corso non sono ancora terminate.

ART. 7 PERCORSO A TEMPO PARZIALE E PERCORSO BREVE

Lo studente ha la possibilità di completare il Corso di studio con modalità flessibile in un tempo inferiore (percorso breve) o superiore alla durata normale (percorso a tempo parziale).

ART. 8 PROVE DI VERIFICA DELLE ATTIVITÀ FORMATIVE

Il piano didattico prevede i casi in cui le attività formative si concludono con un esame con votazione in trentesimi oppure con un giudizio di idoneità.
Le modalità di svolgimento delle verifiche sono stabilite annualmente dal Consiglio di Corso di studio e rese note agli studenti prima dell'inizio delle lezioni nei programmi degli insegnamenti pubblicati sul sito del Corso.

Sono previsti almeno 6 appelli per le verifiche distribuiti nell'arco dell'anno solare, distanziati l'uno dall'altro non meno di 15 giorni.

ART. 9 ATTIVITÀ FORMATIVE A SCELTA DALLO STUDENTE

Lo studente può scegliere tra le attività formative attivate in Ateneo purché coerenti con il percorso formativo.

Il corso di studio considera coerenti con il progetto formativo le attività formative individuate dal Consiglio di Corso di studio e previste nell'allegato piano didattico.

Se lo studente sceglie un'attività formativa diversa da quelle considerate coerenti, secondo i sopraddetti criteri predeterminati, deve fare richiesta al Consiglio di Corso di studio nei termini previsti annualmente e resi noti tramite il sito del Corso.
Il Consiglio valuterà la coerenza della scelta con il percorso formativo dello studente.

A seguito della verifica della adeguatezza della personale preparazione, lo studente che ha conseguito meno di 24 CFU nei settori scientifico disciplinari ING/IND-03, ING/IND-04, ING/IND-05, ING/IND-06, ING/IND-07 nella propria carriera universitaria, deve includere nel proprio piano di studio l'attività formativa Fundamentals of Aerospace Engineering al posto di due esami elettivi. Tali studenti saranno avvisati anche in fase di selezione ed ammissione al corso.

ART. 10 CRITERI DI RICONOSCIMENTO DEI CREDITI ACQUISITI IN ALTRI CORSI DI STUDIO

I crediti formativi universitari acquisiti in altri corsi di studio di Atenei italiani o esteri sono riconosciuti dal Consiglio di Corso di studio fino a concorrenza dei crediti dello stesso settore scientifico disciplinare previsti dal piano didattico allegato.

Il riconoscimento dei crediti avviene sulla base dei seguenti criteri:
- analisi del programma svolto;
- valutazione della congruità dei settori scientifico disciplinari e dei contenuti delle attività formative in cui lo studente ha maturato i crediti con gli obiettivi formativi specifici del Corso di studio e delle singole attività formative da riconoscere, perseguendo comunque la finalità di mobilità degli studenti.

I crediti formativi universitari acquisiti in Corsi di studio della stessa classe sono riconosciuti per non meno della metà.

Qualora, effettuati i riconoscimenti in base alle norme del presente Regolamento, residuino crediti non utilizzati, il Consiglio di Corso di studio può riconoscerli valutando il caso concreto sulla base delle affinità didattiche e culturali.

ART. 11 CRITERI DI RICONOSCIMENTO DELLE CONOSCENZE E ABILITÀ EXTRAUNIVERSITARIE

Possono essere riconosciute conoscenze e abilità extrauniversitarie nei casi previsti dalla normativa vigente. La richiesta di riconoscimento sarà valutata dal Consiglio di Corso di studio tenendo conto del numero massimo di crediti riconoscibili fissato nell'ordinamento didattico del Corso.
Il riconoscimento potrà avvenire qualora l'attività sia ritenuta coerente con gli obiettivi formativi specifici del Corso di studio.

ART. 12 TIROCINIO CURRICULARE

Il Corso di studio prevede un tirocinio curriculare, da svolgersi nel rispetto del Regolamento generale tirocini di Ateneo.

Gli studenti possono altresì attivare un tirocinio in preparazione alla prova finale (in Italia o all'estero) sempre da svolgersi nel rispetto del Regolamento generale tirocini di Ateneo.

ART. 13 PROVA FINALE

a. Caratteristiche della prova finale

La prova finale per il conseguimento della laurea magistrale consiste nella redazione e nella discussione pubblica di una tesi scritta in inglese ed elaborata in modo originale dallo studente su un argomento coerente con gli obiettivi del corso di studio, sotto la guida di un relatore.
La dissertazione deve dimostrare la padronanza degli argomenti, capacità critica, l'attitudine a operare in modo autonomo e una capacità di comunicazione di buon livello.
La prova finale può essere collegata a un progetto o ad un'attività di tirocinio.

b. Modalità di svolgimento della prova finale

La prova finale consiste in una tesi scritta in inglese, discussa oralmente e pubblicamente. Il voto della prova finale avrà una valutazione numerica espressa mediante frazione in n/110, dove n non deve superare 110. L'accordo unanime della Commissione è obbligatorio per l'attribuzione della votazione 110/110 con lode.
Eventuali ulteriori dettagli sulle modalità di assegnazione dell'argomento dell'elaborato, sullo svolgimento delle relative attività, nonché sulla definizione del relatore possono essere precisati dal Consiglio di Corso di Studio in appositi regolamenti.

La Commissione per la prova finale di Laurea Magistrale è nominata dal Consiglio di Corso di Studio, con le modalità e nella composizione previste dal Regolamento Didattico di Ateneo.
Le modalità di redazione e le regole di attribuzione del voto sono pubblicate sul sito del Corso di studio.

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La Commissione Paritetica docenti-studenti ha espresso parere favorevole sulla coerenza dei crediti assegnati alle singole attività formative e gli specifici obiettivi formativi programmati previsti dal piano didattico, ai sensi dell'articolo 12 comma 3 del DM 270/04 e ss.mm.ii.

Anno Accademico **2026/2027**
Classe **LM-20 R-INGEGNERIA AEROSPAZIALE E ASTRONAUTICA**
Corso **6704-AEROSPACE ENGINEERING**

Curriculum: CURRICULUM SPACE (B80)

Primo Anno di Corso

Gruppo: Compulsory courses

TAF: **Ambito:**

Cfu min: **Cfu max:**
Note:

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 000 000 C8396 - 0 - ADVANCED FLUID DYNAMICS (I.C.)				12			Voto
Modulo integrato: C8405 - ADVANCED AERODYNAMICS		ING-IND/06		6	60/0/0/0	No	

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and industrial viscous flows. This module focuses on the derivation and application of the general equations of motion of fluid flows, potential flow theory, and basic concepts of boundary layer theory. It addresses aerodynamic performance of lifting and bluff bodies, with emphasis on applications on both flying and ground vehicles.

Obiettivi inglese: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and industrial viscous flows. This module focuses on the derivation and application of the general equations of motion of fluid flows, potential flow theory, and basic concepts of boundary layer theory. It addresses aerodynamic performance of lifting and bluff bodies, with emphasis on applications on both flying and ground vehicles.

Modulo integrato: C8406 - VISCOUS FLOWS AND TURBULENCE		ING-IND/06		6	60/0/0/0	No	

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and viscous flows. This module covers analytical solutions of canonical viscous flows and introduces advanced concepts of wall-bounded flows, including transition and turbulence.

Obiettivi inglese: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and viscous flows. This module covers analytical solutions of canonical viscous flows and introduces advanced concepts of wall-bounded flows, including transition and turbulence.

6704 B80 000 73184 - 0 - AEROSPACE STRUCTURES (C.I.) 12 Voto

Modulo integrato: 93846 - AEROSPACE STRUCTURES ING-IND/04 6 60/0/0/0 No

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student focuses on the classical and numerical methods for evaluating stress and strain fields in aerospace structures. Particular attention is devoted to semi-monocoque configurations, thin plates, and structural stability problems such as buckling. The student acquires a solid understanding of the mechanical behavior of aerospace components and develops skills in the application of numerical methodologies for design and verification.

Obiettivi inglese: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student focuses on the classical and numerical methods for evaluating stress and strain fields in aerospace structures. Particular attention is devoted to semi-monocoque configurations, thin plates, and structural stability problems such as buckling. The student acquires a solid understanding of the mechanical behavior of aerospace components and develops skills in the application of numerical methodologies for design and verification.

Modulo integrato: 93847 - FATIGUE AND DAMAGE TOLERANCE ING-IND/04 6 60/0/0/0 No

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student studies the fatigue behavior of aerospace structures and the methodologies of damage-tolerant design. The course introduces advanced analytical and numerical methods for stress and strain evaluation and for the conceptual and preliminary design of aircraft. The student gains in-depth knowledge of fatigue life prediction and of the principles of safety and structural integrity in aerospace design.

Obiettivi inglese: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student studies the fatigue behavior of aerospace structures and the methodologies of damage-tolerant design. The course introduces advanced analytical and numerical methods for stress and strain evaluation and for the conceptual and preliminary design of aircraft. The student gains in-depth knowledge of fatigue life prediction and of the principles of safety and structural integrity in aerospace design.

6704 B80 000 93848 - 0 - ATMOSPHERIC FLIGHT DYNAMICS ING-IND/03 6 60/0/0/0 No Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: Starting from the six degrees-of-freedom equations of motion, fundamentals of aircraft longitudinal and lateral-directional dynamics are addressed. Relationship between geometric, inertial and aerodynamic features to pilot commands and external disturbances are highlighted.

Obiettivi inglese: Starting from the six degrees-of-freedom equations of motion, fundamentals of aircraft longitudinal and lateral-directional dynamics are addressed. Relationship between geometric, inertial and aerodynamic features to pilot commands and external disturbances are highlighted.

6704 B80 000 93751 - 0 - NUMERICAL AND MATHEMATICAL METHODS FOR ENGINEERING (I.C.) 12 Voto

Modulo integrato: 37261 - NUMERICAL ANALYSIS MAT/08 6 60/0/0/0 No

Ambito: 2019 - Attività formative affini o integrative C

Obiettivi: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student learns the main numerical methods for solving differential problems of engineering relevance. The course covers the fundamental numerical–mathematical aspects and algorithmic methodologies for the discretization and computational solution of differential equations, emphasizing accuracy, stability, and efficiency in numerical simulations.

Obiettivi inglese: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student learns the main numerical methods for solving differential problems of engineering relevance. The course covers the fundamental numerical–mathematical aspects and algorithmic

methodologies for the discretization and computational solution of differential equations, emphasizing accuracy, stability, and efficiency in numerical simulations.

Modulo integrato: 35143 - MATHEMATICAL METHODS FOR ENGINEERING	MAT/05	6	60/0/0/0	No	

Ambito: 2019 - Attività formative affini o integrative C

Obiettivi: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student focuses on advanced mathematical methods and tools, including complex analysis, approximation theory, and Fourier analysis. The student learns to apply these techniques to the modeling and analysis of problems in aerospace and mechanical engineering, strengthening the connection between mathematical formulation and physical interpretation.

Obiettivi inglese: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student focuses on advanced mathematical methods and tools, including complex analysis, approximation theory, and Fourier analysis. The student learns to apply these techniques to the modeling and analysis of problems in aerospace and mechanical engineering, strengthening the connection between mathematical formulation and physical interpretation.

6704 B80 000 73202 - 0 - SPACECRAFT ORBITAL DYNAMICS AND CONTROL	ING-IND/05	6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The student learns in details the dynamics of the centre of mass of an artificial satellite, both in the case of motion around a planet or for interplanetary trajectories. Also, the strategies and control laws for orbital maintenance, rendezvous, injection into an interplanetary trajectory and around a target planet are explained, as well as techniques for trajectory design using classical impulsive or low-thrust manoeuvres.

Obiettivi inglese: The student learns in details the dynamics of the centre of mass of an artificial satellite, both in the case of motion around a planet or for interplanetary trajectories. Also, the strategies and control laws for orbital maintenance, rendezvous, injection into an interplanetary trajectory and around a target planet are explained, as well as techniques for trajectory design using classical impulsive or low-thrust manoeuvres.

Gruppo: Elective courses for 12 cfu

TAF: D Ambito: 1008 - A scelta dello studente

Cfu min: 12 Cfu max: 12

Note: Fundamentals of Aerospace Engineering I.C. is exclusively reserved to students who achieved less than 24 ECTS in the scientific disciplinary sectors ING/IND-03, ING/IND-04, ING/IND-05, ING/IND-06, ING/IND-07 (or equivalent if obtained abroad) in the previous university career. These students will be notified during selection and admission procedures.

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B80 000 93907 - 0 - EMBEDDED ELECTRONIC SYSTEMS		ING-INF/01		6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student acquires the capability to design and implement embedded electronics for control systems with special reference to aerospace applications. The topics include the fundamental elements of digital electronics, analog and digital sensors acquisition, and actuator control, with a focus on information processing devices, from embedded processors to FPGAs, including architectural and design examples. The student learns to review technical documentation and to use formalisms, notations and merit factors favouring his/her cooperation as a part of interdisciplinary teams comprising experts in information-technology and electronics.

Obiettivi inglese: The student acquires the capability to design and implement embedded electronics for control systems with special reference to aerospace applications. The topics include the fundamental elements of digital electronics, analog and digital sensors acquisition, and actuator control, with a focus on information processing devices, from embedded processors to FPGAs, including architectural and design examples. The student learns to review technical documentation and to use formalisms, notations and merit factors favouring his/her cooperation as a part of interdisciplinary teams comprising experts in information-technology and electronics.

6704 B80 000 93752 - 0 - FUNDAMENTALS OF AEROSPACE ENGINEERING (I.C.) 12 Voto

Note: Fundamentals of Aerospace Engineering I.C. is exclusively reserved to students who achieved less than 24 ECTS in the scientific disciplinary sectors ING/IND-03, ING/IND-04, ING/IND-05, ING/IND-06, ING/IND-07 (or equivalent if obtained abroad) in the previous university career. These students will be notified during selection and admission procedures.

Modulo integrato: 93753 - FUNDAMENTALS OF AERODYNAMICS ING-IND/06 3 30/0/0/0 No

Ambito: 1008 - A scelta dello studente D

Obiettivi: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student learns to describe and interpret the physical mechanisms underlying the generation of lift and drag on aircraft and their components. Basic mathematical models are introduced to estimate aerodynamic forces and moments, forming the foundation for more advanced aerodynamic and design analyses.

Obiettivi inglese: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student learns to describe and interpret the physical mechanisms underlying the generation of lift and drag on aircraft and their components. Basic mathematical models are introduced to estimate aerodynamic forces and moments, forming the foundation for more advanced aerodynamic and design analyses.

Modulo integrato: 93754 - PRINCIPLES OF AEROSPACE PROPULSION ING-IND/07 3 30/0/0/0 No

Ambito: 1008 - A scelta dello studente D

Obiettivi: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student acquires fundamental knowledge of thrust generation and of the main aerospace propulsion systems. The course provides an overview of air-breathing and rocket engines, their operating principles, performance characteristics, and typical fields of application.

Obiettivi inglese: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student acquires fundamental knowledge of thrust generation and of the main aerospace propulsion systems. The course provides an overview of air-breathing and rocket engines, their operating principles, performance characteristics, and typical fields of application.

Modulo integrato: 93905 - FLIGHT MECHANICS ING-IND/03 3 30/0/0/0 No

Ambito: 1008 - A scelta dello studente D

Obiettivi: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student acquires the fundamental analytical tools to study aircraft flight mechanics, including static stability, controllability, and manoeuvrability. The course provides the basis for preliminary analyses of aircraft performance, trim, and loading, with a focus on the longitudinal and lateral–directional behavior of conventional configurations.

Obiettivi inglese: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student acquires the fundamental analytical tools to study aircraft flight mechanics, including static stability, controllability, and manoeuvrability. The course provides the basis for preliminary analyses of aircraft performance, trim, and loading, with a focus on the longitudinal and lateral–directional behavior of conventional configurations.

Modulo integrato: 93756 - FUNDAMENTALS OF AIRCRAFT DESIGN | ING-IND/04 | 3 | 30/0/0/0 | No

Ambito: 1008 - A scelta dello studente D

Obiettivi: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student becomes familiar with the structural layout of aircraft and with the nature of airframe loads. The course introduces the classical methods for the evaluation of stresses and strains in basic aerospace structural elements, with particular emphasis on beams and semi-monocoque configurations, providing the foundation for advanced courses in aerospace structures and design.

Obiettivi inglese: The integrated course Fundamentals of Aerospace Engineering introduces the student to the principles that govern the design and operation of aerospace vehicles. The student develops a multidisciplinary understanding of the main areas of aerospace engineering — aerodynamics, propulsion, structures, and flight mechanics — learning how aerodynamic, structural, and performance aspects interact in defining an aircraft configuration.
In this module, the student becomes familiar with the structural layout of aircraft and with the nature of airframe loads. The course introduces the classical methods for the evaluation of stresses and strains in basic aerospace structural elements, with particular emphasis on beams and semi-monocoque configurations, providing the foundation for advanced courses in aerospace structures and design.

6704 B80 000 91187 - 0 - FUNDAMENTALS OF ASTROPHYSICS | FIS/05 | 6 | 60/0/0/0 | No | Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The aim of this course is to obtain a general understanding of physical properties of stars and galaxies. At the end of the lectures the student will know the equations that regulate the internal structure of the stars, the sources of energy production, the structure of stellar atmosphere and the formation theory of the spectral lines. The student will acquire a general knowledge of morphological, structural and dynamical properties of stellar systems (stellar clusters, galaxies, ...). Hence, he/she will acquire the necessary bases to understand the structural and evolutionary properties of stars and galaxies.

Obiettivi inglese: The aim of this course is to obtain a general understanding of physical properties of stars and galaxies. At the end of the lectures the student will know the equations that regulate the internal structure of the stars, the sources of energy production, the structure of stellar atmosphere and the formation theory of the spectral lines. The student will acquire a general knowledge of morphological, structural and dynamical properties of stellar systems (stellar clusters, galaxies, ...). Hence, he/she will acquire the necessary bases to understand the structural and evolutionary properties of stars and galaxies.

Note: Taught in Bologna - Laurea Magistrale in Physics

6704 B80 000 93849 - 0 - HELICOPTERS | ING-IND/03 | 6 | 60/0/0/0 | No | Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: Starting from the decoupled and linearized equations of motion, fundamentals of aircraft feedback control are addressed.. Design tools for aircraft stability augmentation systems and autopilots are developed.

Obiettivi inglese: Starting from the decoupled and linearized equations of motion, fundamentals of aircraft feedback control are addressed. Design tools for aircraft stability augmentation systems and autopilots are developed.

6704 B80 000 99256 - 0 - LAUNCHERS AND RE-ENTRY | ING-IND/05 | 6 | 60/0/0/0 | No | Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: During the course, the student learns how to model and analyze launch vehicles' components and subsystems, and their dynamics and ascent and re-entry reference trajectory. In addition, the student acquires the fundamentals of guidance, navigation and control algorithms applied to ascent and re-entry trajectories, and the needed navigation sensors and control actuators.

Obiettivi inglese: During the course, the student learns how to model and analyze launch vehicles' components and subsystems, and their dynamics and ascent and re-entry reference trajectory. In addition, the student acquires the fundamentals of guidance, navigation and control algorithms applied to ascent and re-entry trajectories, and the needed navigation sensors and control actuators.

6704 B80 000 73369 - 0 - MATERIALS CHEMISTRY | CHIM/07 | 6 | 60/0/0/0 | No | Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The course is focused on the applications of the principles of chemistry to the description of the behaviour of the solid state. At the end of the course the student will have the basis to understand the relationships between the nature and arrangements of the atoms, ions or molecules comprising a material and its overall bulk structural and physical properties. The acquired competences on advanced materials will be focused on aerospace structural design.

Obiettivi inglese: The course is focused on the applications of the principles of chemistry to the description of the behaviour of the solid state. At the end of the course the student will have the basis to understand the relationships between the nature and arrangements of the atoms, ions or molecules comprising a material and its overall bulk structural and physical properties. The acquired competences on advanced materials will be focused on aerospace structural design.

6704 B80 000 73346 - 0 - SIMULATION AND MODELLING IN FLUID DYNAMICS	ING-IND/06		6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The course is meant to provide students with the tools to simulate and understand turbulent flows. This includes basic elements of computational fluid dynamics and turbulence modelling. The student learns how to apply statistical methods to analyse turbulent flows and use his/her comprehension in turbulence to select the appropriate simulation techniques for the various applications.

Obiettivi inglese: The course is meant to provide students with the tools to simulate and understand turbulent flows. This includes basic elements of computational fluid dynamics and turbulence modelling. The student learns how to apply statistical methods to analyse turbulent flows and use his/her comprehension in turbulence to select the appropriate simulation techniques for the various applications.

Secondo Anno di Corso

Gruppo: Compulsory courses

TAF: Ambito:

Cfu min: Cfu max:

Note:

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B80 000 73204 - 0 - RADIO COMMUNICATION AND RADAR SYSTEMS		ING-INF/03		6	60/0/0/0	No	Voto

Ambito: 2019 - Attività formative affini o integrative C

Obiettivi: The student acquires knowledge of both basic criteria for the design of radio communication and radar systems, and the metrics to evaluate the performance of such (analogue and digital) systems.

Obiettivi inglese: The student acquires knowledge of both basic criteria for the design of radio communication and radar systems, and the metrics to evaluate the performance of such (analogue and digital) systems.

6704 B80 000 93854 - 0 - ROCKET PROPULSION		ING-IND/07		6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The student acquires information required to understand the behavior of all rocket engines (both liquid and solid). This is done starting from the analysis of the propulsion requirements needed for each mission, then approaching the general design of rocket engines.

Obiettivi inglese: The student acquires information required to understand the behavior of all rocket engines (both liquid and solid). This is done starting from the analysis of the propulsion requirements needed for each mission, then approaching the general design of rocket engines.

6704 B80 000 73208 - 0 - SPACECRAFT ATTITUDE DYNAMICS AND CONTROL		ING-IND/05		6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: During the course, the student learns how to model and analyze the attitude dynamics of a spacecraft, and the principles which drive the design of an attitude determination and control subsystem. In particular, in the first part of the course the student acquires the fundamentals of attitude representation and dynamics. In the second part, he/she learns the algorithms and sensors which are employed for estimating the attitude, together with the algorithms and actuators for its control.

Obiettivi inglese: During the course, the student learns how to model and analyze the attitude dynamics of a spacecraft, and the principles which drive the design of an attitude determination and control subsystem. In particular, in the first part of the course the student acquires the fundamentals of attitude representation and dynamics. In the second part, he/she learns the algorithms and sensors which are employed for estimating the attitude, together with the algorithms and actuators for its control.

6704 B80 000 77956 - 0 - SPACECRAFT SUBSYSTEMS AND SPACE MISSION DESIGN	ING-IND/05	6	60/0/0/0	No	Voto	

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: In the course, the students are introduced to the fundamentals of space systems engineering and the key aspects of spacecraft systems design. He/she will also learn the design considerations which come into play in laying out a space mission and its preliminary design. The students, take on a real-world problem and in a step-by-step and assignment driven approach, design a space mission that can provide the solution. They are exposed to the trade-off between performance, cost and schedule in a typical space mission design.

Obiettivi inglese: In the course, the students are introduced to the fundamentals of space systems engineering and the key aspects of spacecraft systems design. He/she will also learn the design considerations which come into play in laying out a space mission and its preliminary design. The students, take on a real-world problem and in a step-by-step and assignment driven approach, design a space mission that can provide the solution. They are exposed to the trade-off between performance, cost and schedule in a typical space mission design.

Gruppo: Elective courses for 6 cfu

TAF: D Ambito: 1008 - A scelta dello studente

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B80 000 93853 - 0 - ADVANCED GUIDANCE AND CONTROL OF AIRCRAFT AND SPACECRAFT		ING-INF/04		6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The objective of the course is to provide the students with modern guidance and control techniques which apply to all flying vehicles without distinction. The course is intended for students in aerospace engineering, oriented to both atmospheric and space flight. The focus is on the application of multivariable robust OPTIMAL CONTROL theory and INTELLIGENT CONTROL, based on Neural Networks and Machine Learning, for guidance and control of fixed/rotary wing aircraft, spacecraft, missiles and re-entry vehicles. The overall project of the autopilots currently implemented in commercial (airliner) and general aviation aircraft is proposed jointly with modern guidance and control systems for satellites, space stations, microsatellites, missiles and re-entry vehicles. An appealing feature of the course is the ready and extensive use of MATLAB®/Simulink® codes in the many solved examples illustrating guidance and control design, analysis and implementation. Furthermore, at the end of the course, the operation and programming of commercial autopilots are practically taught by using a certified flight simulator c/o an ENAC-certified flight school.

Obiettivi inglese: The objective of the course is to provide the students with modern guidance and control techniques which apply to all flying vehicles without distinction. The course is intended for students in aerospace engineering, oriented to both atmospheric and space flight. The focus is on the application of multivariable robust OPTIMAL CONTROL theory and INTELLIGENT CONTROL, based on Neural Networks and Machine Learning, for guidance and control of fixed/rotary wing aircraft, spacecraft, missiles and re-entry vehicles. The overall project of the autopilots currently implemented in commercial (airliner) and general aviation aircraft is proposed jointly with modern guidance and control systems for satellites, space stations, microsatellites, missiles and re-entry vehicles. An appealing feature of the course is the ready and extensive use of MATLAB®/Simulink® codes in the many solved examples illustrating guidance and control design, analysis and implementation. Furthermore, at the end of the course, the operation and programming of commercial autopilots are practically taught by using a certified flight simulator c/o an ENAC-certified flight school.

6704 B80 000 73205 - 0 - AEROSPACE TECHNOLOGIES AND MATERIALS	ING-IND/04	6	60/0/0/0	No	Voto	

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student is able to apply the principles of materials and process selection for minimum weight design in aerospace applications. The student knows how to identify the main factors influencing the selection of the manufacturing process. The student acquires also competences on advanced structural materials for aircraft components, propulsion applications and space vehicles.

Obiettivi inglese: The student is able to apply the principles of materials and process selection for minimum weight design in aerospace applications. The student knows how to identify the main factors influencing the selection of the manufacturing process. The student acquires also competences on advanced structural materials for aircraft components, propulsion applications and space vehicles.

6704 000 000 B8229 - 0 - AIRCRAFT DESIGN	ING-IND/04	6	60/0/0/0	No	Voto	

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student gains a deep understanding of the fundamental methodologies adopted for the conceptual and preliminary design of commercial aircraft, starting from the mission requirements and taking into account all the major technical, regulation and environmental constraints. The design is conceived in an integrated multidisciplinary environment, with a careful analysis of the most advanced optimization techniques. During the course, the students are involved in the complete design of a realistic configuration, from the preliminary sizing and vehicle configuration, considering aerodynamics, flight mechanics, propulsion and structural constraints. Finally, a cost analysis will be performed. Furthermore, the lessons learned from accidents and incidents that have occurred throughout the history of aviation and which have transformed aerospace structural design methodologies will be explored in depth.

Obiettivi inglese: The student gains a deep understanding of the fundamental methodologies adopted for the conceptual and preliminary design of commercial aircraft, starting from the mission requirements and taking into account all the major technical, regulation and environmental constraints. The design is conceived in an integrated multidisciplinary environment, with a careful analysis of the most advanced optimization

techniques. During the course, the students are involved in the complete design of a realistic configuration, from the preliminary sizing and vehicle configuration, considering aerodynamics, flight mechanics, propulsion and structural constraints. Finally, a cost analysis will be performed. Furthermore, the lessons learned from accidents and incidents that have occurred throughout the history of aviation and which have transformed aerospace structural design methodologies will be explored in depth.

6704 B80 000 73194 - 0 - DESIGN METHODS IN THE AEROSPACE INDUSTRY	ING-IND/15	6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student gains a clear understanding of the design process used in the aerospace industry to develop new products. In detail, the student knows the proper methodologies to carry out a synthetic approach to the design of new vehicles, focusing the attention on the conceptual and preliminary design methods and tools useful for the aeronautical products development.

Obiettivi inglese: The student gains a clear understanding of the design process used in the aerospace industry to develop new products. In detail, the student knows the proper methodologies to carry out a synthetic approach to the design of new vehicles, focusing the attention on the conceptual and preliminary design methods and tools useful for the aeronautical products development.

6704 B80 000 73198 - 0 - EXPERIMENTAL METHODS IN AERODYNAMICS	ING-IND/06	6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: Aim of the course is to give the student the fundamental knowledge to plan and execute an experimental campaign in Aero and Fluid-dynamics, as well as the knowledge of the most important instruments and experimental techniques in Aerodynamics.
Specifically, at the end of the course the student will be able to:
- Determine the relevant variables and non-dimensional parameters for a given fluid-dynamic system;
- Choose and/or design the most appropriate experimental setup and measurement instrument
- Critically evaluate and analyze the experimental data together with the associated uncertainty"

Obiettivi inglese: Aim of the course is to give the student the fundamental knowledge to plan and execute an experimental campaign in Aero and Fluid-dynamics, as well as the knowledge of the most important instruments and experimental techniques in Aerodynamics.
Specifically, at the end of the course the student will be able to:
- Determine the relevant variables and non-dimensional parameters for a given fluid-dynamic system;
- Choose and/or design the most appropriate experimental setup and measurement instrument
- Critically evaluate and analyze the experimental data together with the associated uncertainty"

6704 000 000 B4005 - 0 - SPACECRAFT DEEP SPACE NAVIGATION	ING-IND/05	6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student learns in detail the techniques to perform the navigation of an artificial satellite outside the Earth orbit, from the cis-lunar to the deep space environment. The first part of the course focuses on the orbit determination process, used to estimate the past trajectory of a spacecraft from a set of measurements. In the second part, the main strategies to correct the deviations from the reference trajectory are explained. The theoretical framework is complemented by real-world examples and practical exercises using tracking data from past and ongoing deep space missions.

Obiettivi inglese: The student learns in detail the techniques to perform the navigation of an artificial satellite outside the Earth orbit, from the cis-lunar to the deep space environment. The first part of the course focuses on the orbit determination process, used to estimate the past trajectory of a spacecraft from a set of measurements. In the second part, the main strategies to correct the deviations from the reference trajectory are explained. The theoretical framework is complemented by real-world examples and practical exercises using tracking data from past and ongoing deep space missions.

6704 B80 000 93850 - 0 - UNMANNED SYSTEMS		ING-IND/03	6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: At the end of the course, the student is knows how to create a mathematical model of an unmanned aircraft and he knows how to design and implements the main attitude and trajectory control systems.
Through experimental lab activities, he also gets familiar with the fundamentals of Remote-Piloted Aircraft Systems flight planning and operations.

Obiettivi inglese: At the end of the course, the student is knows how to create a mathematical model of an unmanned aircraft and he knows how to design and implements the main attitude and trajectory control systems.
Through experimental lab activities, he also gets familiar with the fundamentals of Remote-Piloted Aircraft Systems flight planning and operations.

Gruppo: Final project

TAF: Ambito:

Cfu min: 24 Cfu max: 24

Note: Students must select the activities of one of the two groups up to 24 cfu.

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
Final project (18 + 6 cfu)				0-24			
6704 B80 000 35500 - 0 - FINAL PROJECT				6	0/0/0/0	No	

Ambito: 1018 - Per la prova finale E

Obiettivi: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

Obiettivi inglese: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

6704 B80 000 90779 - 0 - INTERNSHIP FOR PREPARATION FOR THE FINAL PROJECT			18	0/0/450/0	No	Giudizio

Ambito: 1018 - Per la prova finale E

Obiettivi: At the end of the internship in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

Obiettivi inglese: At the end of the internship in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

6704 B80 000 93851 - 0 - INTERNSHIP FOR PREPARATION OF THE FINAL PROJECT ABROAD			18	0/0/450/0	No	Giudizio

Ambito: 1018 - Per la prova finale E

Obiettivi: At the end of the internship abroad in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

Obiettivi inglese: At the end of the internship abroad in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

6704 B80 000 93852 - 0 - PREPARATION OF THE FINAL PROJECT ABROAD	18	0/0/450/0	No	Giudizio	

Ambito: 1018 - Per la prova finale E

Obiettivi: Students interested in theses of larger complexity extend their basic knowledge through extensive literature research and the study of topics not explicitly addressed in courses that are part of their curriculum. The student, guided by a professor and included in a major project carried out abroad, collaborates with the structured staff for the preparation of the university final project.

Obiettivi inglese: Students interested in theses of larger complexity extend their basic knowledge through extensive literature research and the study of topics not explicitly addressed in courses that are part of their curriculum. The student, guided by a professor and included in a major project carried out abroad, collaborates with the structured staff for the preparation of the university final project.

Final project (24 cfu)	0-24				
6704 B80 000 30800 - 0 - FINAL PROJECT	24	0/0/0/0	No		

Ambito: 1018 - Per la prova finale E

Obiettivi: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

Obiettivi inglese: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

Gruppo: Internship

TAF: F Ambito: 1146 - Tirocini formativi e di orientamento

Cfu min: 6 Cfu max: 6

Note: All the students which carry out activities in a Laboratory of the University of Bologna MUST follow the Health and Safety Training in Work-Places.
This training is made up of three parts: the first two are online, the third is delivered as a lesson (in presence or on the Teams platform).
Information can be found at the page “Health And Safety In Workplaces – Training Courses For Students”, in the section Studying / Teaching Activities of the web site of your course degree

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B80 000 71137 - 0 - INTERNSHIP				6	0/0/150/0	No	Giudizio

Ambito: 1146 - Tirocini formativi e di orientamento F

Obiettivi: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program.

Obiettivi inglese: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program.

6704 B80 000 85319 - 0 - INTERNSHIP ABROAD	6	0/0/150/0	No	Giudizio	

Ambito: 1146 - Tirocini formativi e di orientamento F

Obiettivi: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program in a foreign company/university/laboratory/institution.

Obiettivi inglese: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program in a foreign company/university/laboratory/institution.

Anno Accademico **2026/2027**
Classe **LM-20 R-INGEGNERIA AEROSPAZIALE E ASTRONAUTICA**
Corso **6704-AEROSPACE ENGINEERING**

Curriculum: CURRICULUM AERONAUTICS (B79)

Primo Anno di Corso

Gruppo: Compulsory Courses

TAF: **Ambito:**

Cfu min: **Cfu max:**
Note:

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 000 000 C8396 - 0 - ADVANCED FLUID DYNAMICS (I.C.)				12			Voto
Modulo integrato: C8405 - ADVANCED AERODYNAMICS		ING-IND/06		6	60/0/0/0	No	

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and industrial viscous flows. This module focuses on the derivation and application of the general equations of motion of fluid flows, potential flow theory, and basic concepts of boundary layer theory. It addresses aerodynamic performance of lifting and bluff bodies, with emphasis on applications on both flying and ground vehicles.

Obiettivi inglese: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and industrial viscous flows. This module focuses on the derivation and application of the general equations of motion of fluid flows, potential flow theory, and basic concepts of boundary layer theory. It addresses aerodynamic performance of lifting and bluff bodies, with emphasis on applications on both flying and ground vehicles.

Modulo integrato: C8406 - VISCOUS FLOWS AND TURBULENCE		ING-IND/06		6	60/0/0/0	No	

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and viscous flows. This module covers analytical solutions of canonical viscous flows and introduces advanced concepts of wall-bounded flows, including transition and turbulence.

Obiettivi inglese: The course provides a comprehensive understanding of advanced concepts in fluid mechanics, bridging theoretical foundations with applications in aerodynamics and viscous flows. This module covers analytical solutions of canonical viscous flows and introduces advanced concepts of wall-bounded flows, including transition and turbulence.

6704 B79 000 73184 - 0 - AEROSPACE STRUCTURES (C.I.) 12 Voto

Modulo integrato: 93846 - AEROSPACE STRUCTURES ING-IND/04 6 60/0/0/0 No

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student focuses on the classical and numerical methods for evaluating stress and strain fields in aerospace structures. Particular attention is devoted to semi-monocoque configurations, thin plates, and structural stability problems such as buckling. The student acquires a solid understanding of the mechanical behavior of aerospace components and develops skills in the application of numerical methodologies for design and verification.

Obiettivi inglese: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student focuses on the classical and numerical methods for evaluating stress and strain fields in aerospace structures. Particular attention is devoted to semi-monocoque configurations, thin plates, and structural stability problems such as buckling. The student acquires a solid understanding of the mechanical behavior of aerospace components and develops skills in the application of numerical methodologies for design and verification.

Modulo integrato: 93847 - FATIGUE AND DAMAGE TOLERANCE ING-IND/04 6 60/0/0/0 No

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student studies the fatigue behavior of aerospace structures and the methodologies of damage-tolerant design. The course introduces advanced analytical and numerical methods for stress and strain evaluation and for the conceptual and preliminary design of aircraft. The student gains in-depth knowledge of fatigue life prediction and of the principles of safety and structural integrity in aerospace design.

Obiettivi inglese: The integrated course Aerospace Structures provides the student with a comprehensive understanding of the mechanical behavior, analysis, and design of aerospace structures. Through the combination of classical analytical approaches, numerical simulation techniques, and design-oriented methodologies, the student develops the ability to evaluate stresses, strains, and stability phenomena in thin-walled and semi-monocoque configurations, and to apply these concepts to the conceptual and preliminary design of aircraft.
In this module, the student studies the fatigue behavior of aerospace structures and the methodologies of damage-tolerant design. The course introduces advanced analytical and numerical methods for stress and strain evaluation and for the conceptual and preliminary design of aircraft. The student gains in-depth knowledge of fatigue life prediction and of the principles of safety and structural integrity in aerospace design.

6704 B79 000 93848 - 0 - ATMOSPHERIC FLIGHT DYNAMICS ING-IND/03 6 60/0/0/0 No Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: Starting from the six degrees-of-freedom equations of motion, fundamentals of aircraft longitudinal and lateral-directional dynamics are addressed. Relationship between geometric, inertial and aerodynamic features to pilot commands and external disturbances are highlighted.

Obiettivi inglese: Starting from the six degrees-of-freedom equations of motion, fundamentals of aircraft longitudinal and lateral-directional dynamics are addressed. Relationship between geometric, inertial and aerodynamic features to pilot commands and external disturbances are highlighted.

6704 B79 000 93849 - 0 - HELICOPTERS ING-IND/03 6 60/0/0/0 No Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: Starting from the decoupled and linearized equations of motion, fundamentals of aircraft feedback control are addressed. Design tools for aircraft stability augmentation systems and autopilots are developed.

Obiettivi inglese: Starting from the decoupled and linearized equations of motion, fundamentals of aircraft feedback control are addressed. Design tools for aircraft stability augmentation systems and autopilots are developed.

6704 B79 000 93751 - 0 - NUMERICAL AND MATHEMATICAL METHODS FOR ENGINEERING (I.C.)		12			Voto
Modulo integrato: 37261 - NUMERICAL ANALYSIS	MAT/08	6	60/0/0/0	No	

Ambito: 2019 - Attività formative affini o integrative C

Obiettivi: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student learns the main numerical methods for solving differential problems of engineering relevance. The course covers the fundamental numerical–mathematical aspects and algorithmic methodologies for the discretization and computational solution of differential equations, emphasizing accuracy, stability, and efficiency in numerical simulations.

Obiettivi inglese: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student learns the main numerical methods for solving differential problems of engineering relevance. The course covers the fundamental numerical–mathematical aspects and algorithmic methodologies for the discretization and computational solution of differential equations, emphasizing accuracy, stability, and efficiency in numerical simulations.

Modulo integrato: 35143 - MATHEMATICAL METHODS FOR ENGINEERING	MAT/05	6	60/0/0/0	No	

Ambito: 2019 - Attività formative affini o integrative C

Obiettivi: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student focuses on advanced mathematical methods and tools, including complex analysis, approximation theory, and Fourier analysis. The student learns to apply these techniques to the modeling and analysis of problems in aerospace and mechanical engineering, strengthening the connection between mathematical formulation and physical interpretation.

Obiettivi inglese: The integrated course Numerical and Mathematical Methods for Engineering provides the student with advanced analytical and computational tools for the formulation and solution of engineering problems. The student develops an understanding of both the theoretical foundations of applied mathematics and the numerical techniques used to model and solve differential and applied problems, with particular reference to aerospace and mechanical engineering.
In this module, the student focuses on advanced mathematical methods and tools, including complex analysis, approximation theory, and Fourier analysis. The student learns to apply these techniques to the modeling and analysis of problems in aerospace and mechanical engineering, strengthening the connection between mathematical formulation and physical interpretation.

Gruppo: Elective Courses for 12 cfu

TAF: D Ambito: 1008 - A scelta dello studente

Cfu min: 12 Cfu max: 12

Note: Fundamentals of Aerospace Engineering I.C. is exclusively reserved to students who achieved less than 24 ECTS in the scientific disciplinary sectors ING/IND-03, ING/IND-04, ING/IND-05, ING/IND-06, ING/IND-07 (or equivalent if obtained abroad) in the previous university career. These students will be notified during selection and admission procedures.

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B79 000 93907 - 0 - EMBEDDED ELECTRONIC SYSTEMS		ING-INF/01		6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student acquires the capability to design and implement embedded electronics for control systems with special reference to aerospace applications. The topics include the fundamental elements of digital electronics, analog and digital sensors acquisition, and actuator control, with a focus on information processing devices, from embedded processors to FPGAs, including architectural and design examples. The student learns to review technical documentation and to use formalisms, notations and merit factors favouring his/her cooperation as a part of interdisciplinary teams comprising experts in information-technology and electronics.

Obiettivi inglese: The student acquires the capability to design and implement embedded electronics for control systems with special reference to aerospace applications. The topics include the fundamental elements of digital electronics, analog and digital sensors acquisition, and actuator control, with a focus on information processing devices, from embedded processors to FPGAs, including architectural and design examples. The student learns to review technical documentation and to use formalisms, notations and merit factors favouring his/her cooperation as a part of interdisciplinary teams comprising experts in information-technology and electronics.

6704 B79 000 93752 - 0 - FUNDAMENTALS OF AEROSPACE ENGINEERING (I.C.) 12 Voto

Note: Fundamentals of Aerospace Engineering I.C. is exclusively reserved to students who achieved less than 24 ECTS in the scientific disciplinary sectors ING/IND-03, ING/IND-04, ING/IND-05, ING/IND-06, ING/IND-07 (or equivalent if obtained abroad) in the previous university career. These students will be notified during selection and admission procedures.

6704 B79 000 91187 - 0 - FUNDAMENTALS OF ASTROPHYSICS FIS/05 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The aim of this course is to obtain a general understanding of physical properties of stars and galaxies. At the end of the lectures the student will know the equations that regulate the internal structure of the stars, the sources of energy production, the structure of stellar atmosphere and the formation theory of the spectral lines. The student will acquire a general knowledge of morphological, structural and dynamical properties of stellar systems (stellar clusters, galaxies, ...). Hence, he/she will acquire the necessary bases to understand the structural and evolutionary properties of stars and galaxies.

Obiettivi inglese: The aim of this course is to obtain a general understanding of physical properties of stars and galaxies. At the end of the lectures the student will know the equations that regulate the internal structure of the stars, the sources of energy production, the structure of stellar atmosphere and the formation theory of the spectral lines. The student will acquire a general knowledge of morphological, structural and dynamical properties of stellar systems (stellar clusters, galaxies, ...). Hence, he/she will acquire the necessary bases to understand the structural and evolutionary properties of stars and galaxies.

Note: Taught in Bologna - Second cycle Degree in Physics

6704 B79 000 73369 - 0 - MATERIALS CHEMISTRY CHIM/07 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The course is focused on the applications of the principles of chemistry to the description of the behaviour of the solid state. At the end of the course the student will have the basis to understand the relationships between the nature and arrangements of the atoms, ions or molecules comprising a material and its overall bulk structural and physical properties. The acquired competences on advanced materials will be focused on aerospace structural design.

Obiettivi inglese: The course is focused on the applications of the principles of chemistry to the description of the behaviour of the solid state. At the end of the course the student will have the basis to understand the relationships between the nature and arrangements of the atoms, ions or molecules comprising a material and its overall bulk structural and physical properties. The acquired competences on advanced materials will be focused on aerospace structural design.

6704 B79 000 73346 - 0 - SIMULATION AND MODELLING IN FLUID DYNAMICS ING-IND/06 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The course is meant to provide students with the tools to simulate and understand turbulent flows. This includes basic elements of computational fluid dynamics and turbulence modelling. The student learns how to apply statistical methods to analyse turbulent flows and use his/her comprehension in turbulence to select the appropriate simulation techniques for the various applications.

Obiettivi inglese: The course is meant to provide students with the tools to simulate and understand turbulent flows. This includes basic elements of computational fluid dynamics and turbulence modelling. The student learns how to apply statistical methods to analyse turbulent flows and use his/her comprehension in turbulence to select the appropriate simulation techniques for the various applications.

6704 B79 000 73202 - 0 - SPACECRAFT ORBITAL DYNAMICS AND CONTROL ING-IND/05 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student learns in details the dynamics of the centre of mass of an artificial satellite, both in the case of motion around a planet or for interplanetary trajectories. Also, the strategies and control laws for orbital maintenance, rendezvous, injection into an interplanetary trajectory and around a target planet are explained, as well as techniques for trajectory design using classical impulsive or low-thrust manoeuvres.

Obiettivi inglese: The student learns in details the dynamics of the centre of mass of an artificial satellite, both in the case of motion around a planet or for interplanetary trajectories. Also, the strategies and control laws for orbital maintenance, rendezvous, injection into an interplanetary trajectory and around a target planet are explained, as well as techniques for trajectory design using classical impulsive or low-thrust manoeuvres.

Secondo Anno di Corso

Gruppo: Compulsory Courses

TAF: Ambito:

Cfu min: Cfu max:

Note:

Attività formativa	TIP	SSD	TAF	CFU	ORE	F/E/L/N	FREQ.	VER.

6704 B79 000 73205 - 0 - AEROSPACE TECHNOLOGIES AND MATERIALS	ING-IND/04	6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The student is able to apply the principles of materials and process selection for minimum weight design in aerospace applications. The student knows how to identify the main factors influencing the selection of the manufacturing process. The student acquires also competences on advanced structural materials for aircraft components, propulsion applications and space vehicles.

Obiettivi inglese: The student is able to apply the principles of materials and process selection for minimum weight design in aerospace applications. The student knows how to identify the main factors influencing the selection of the manufacturing process. The student acquires also competences on advanced structural materials for aircraft components, propulsion applications and space vehicles.

6704 000 000 B8229 - 0 - AIRCRAFT DESIGN	ING-IND/04	6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: The student gains a deep understanding of the fundamental methodologies adopted for the conceptual and preliminary design of commercial aircraft, starting from the mission requirements and taking into account all the major technical, regulation and environmental constraints. The design is conceived in an integrated multidisciplinary environment, with a careful analysis of the most advanced optimization techniques. During the course, the students are involved in the complete design of a realistic configuration, from the preliminary sizing and vehicle configuration, considering aerodynamics, flight mechanics, propulsion and structural constraints. Finally, a cost analysis will be performed. Furthermore, the lessons learned from accidents and incidents that have occurred throughout the history of aviation and which have transformed aerospace structural design methodologies will be explored in depth.

Obiettivi inglese: The student gains a deep understanding of the fundamental methodologies adopted for the conceptual and preliminary design of commercial aircraft, starting from the mission requirements and taking into account all the major technical, regulation and environmental constraints. The design is conceived in an integrated multidisciplinary environment, with a careful analysis of the most advanced optimization techniques. During the course, the students are involved in the complete design of a realistic configuration, from the preliminary sizing and vehicle configuration, considering aerodynamics, flight mechanics, propulsion and structural constraints. Finally, a cost analysis will be performed. Furthermore, the lessons learned from accidents and incidents that have occurred throughout the history of aviation and which have transformed aerospace structural design methodologies will be explored in depth.

6704 B79 000 73198 - 0 - EXPERIMENTAL METHODS IN AERODYNAMICS	ING-IND/06	6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: Aim of the course is to give the student the fundamental knowledge to plan and execute an experimental campaign in Aero and Fluid-dynamics, as well as the knowledge of the most important instruments and experimental techniques in Aerodynamics.
Specifically, at the end of the course the student will be able to:
- Determine the relevant variables and non-dimensional parameters for a given fluid-dynamic system;
- Choose and/or design the most appropriate experimental setup and measurement instrument
- Critically evaluate and analyze the experimental data together with the associated uncertainty"

Obiettivi inglese: Aim of the course is to give the student the fundamental knowledge to plan and execute an experimental campaign in Aero and Fluid-dynamics, as well as the knowledge of the most important instruments and experimental techniques in Aerodynamics.
Specifically, at the end of the course the student will be able to:
- Determine the relevant variables and non-dimensional parameters for a given fluid-dynamic system;
- Choose and/or design the most appropriate experimental setup and measurement instrument
- Critically evaluate and analyze the experimental data together with the associated uncertainty"

6704 B79 000 93850 - 0 - UNMANNED SYSTEMS		ING-IND/03	6	60/0/0/0	No	Voto

Ambito: 563 - Ingegneria aerospaziale ed astronautica B

Obiettivi: At the end of the course, the student is knows how to create a mathematical model of an unmanned aircraft and he knows how to design and implements the main attitude and trajectory control systems.
Through experimental lab activities, he also gets familiar with the fundamentals of Remote-Piloted Aircraft Systems flight planning and operations.

Obiettivi inglese: At the end of the course, the student is knows how to create a mathematical model of an unmanned aircraft and he knows how to design and implements the main attitude and trajectory control systems.
Through experimental lab activities, he also gets familiar with the fundamentals of Remote-Piloted Aircraft Systems flight planning and operations.

Gruppo: Elective Courses for 6 cfu

TAF: D Ambito: 1008 - A scelta dello studente

Cfu min: 6 Cfu max: 6

Note:

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B79 000 93853 - 0 - ADVANCED GUIDANCE AND CONTROL OF AIRCRAFT AND SPACECRAFT		ING-INF/04		6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The objective of the course is to provide the students with modern guidance and control techniques which apply to all flying vehicles without distinction. The course is intended for students in aerospace engineering, oriented to both atmospheric and space flight. The focus is on the application of multivariable robust OPTIMAL CONTROL theory and INTELLIGENT CONTROL, based on Neural Networks and Machine Learning, for guidance and control of fixed/rotary wing aircraft, spacecraft, missiles and re-entry vehicles. The overall project of the autopilots currently implemented in commercial (airliner) and general aviation aircraft is proposed jointly with modern guidance and control systems for satellites, space stations, microsatellites, missiles and re-entry vehicles. An appealing feature of the course is the ready and extensive use of MATLAB®/Simulink® codes in the many solved examples illustrating guidance and control design, analysis and implementation. Furthermore, at the end of the course, the operation and programming of commercial autopilots are practically taught by using a certified flight simulator c/o an ENAC-certified flight school.

Obiettivi inglese: The objective of the course is to provide the students with modern guidance and control techniques which apply to all flying vehicles without distinction. The course is intended for students in aerospace engineering, oriented to both atmospheric and space flight. The focus is on the application of multivariable robust OPTIMAL CONTROL theory and INTELLIGENT CONTROL, based on Neural Networks and Machine Learning, for guidance and control of fixed/rotary wing aircraft, spacecraft, missiles and re-entry vehicles. The overall project of the autopilots currently implemented in commercial (airliner) and general aviation aircraft is proposed jointly with modern guidance and control systems for satellites, space stations, microsatellites, missiles and re-entry vehicles. An appealing feature of the course is the ready and extensive use of MATLAB®/Simulink® codes in the many solved examples illustrating guidance and control design, analysis and implementation. Furthermore, at the end of the course, the operation and programming of commercial autopilots are practically taught by using a certified flight simulator c/o an ENAC-certified flight school.

6704 B79 000 73194 - 0 - DESIGN METHODS IN THE AEROSPACE INDUSTRY		ING-IND/15	6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student gains a clear understanding of the design process used in the aerospace industry to develop new products. In detail, the student knows the proper methodologies to carry out a synthetic approach to the design of new vehicles, focusing the attention on the conceptual and preliminary design methods and tools useful for the aeronautical products development.

Obiettivi inglese: The student gains a clear understanding of the design process used in the aerospace industry to develop new products. In detail, the student knows the proper methodologies to carry out a synthetic approach to the design of new vehicles, focusing the attention on the conceptual and preliminary design methods and tools useful for the aeronautical products development.

6704 B79 000 73204 - 0 - RADIO COMMUNICATION AND RADAR SYSTEMS		ING-INF/03	6	60/0/0/0	No	Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student acquires knowledge of both basic criteria for the design of radio communication and radar systems, and the metrics to evaluate the performance of such (analogue and digital) systems.

Obiettivi inglese: The student acquires knowledge of both basic criteria for the design of radio communication and radar systems, and the metrics to evaluate the performance of such (analogue and digital) systems.

6704 B79 000 93854 - 0 - ROCKET PROPULSION ING-IND/07 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student acquires information required to understand the behavior of all rocket engines (both liquid and solid). This is done starting from the analysis of the propulsion requirements needed for each mission, then approaching the general design of rocket engines.

Obiettivi inglese: The student acquires information required to understand the behavior of all rocket engines (both liquid and solid). This is done starting from the analysis of the propulsion requirements needed for each mission, then approaching the general design of rocket engines.

6704 B79 000 73208 - 0 - SPACECRAFT ATTITUDE DYNAMICS AND CONTROL ING-IND/05 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: During the course, the student learns how to model and analyze the attitude dynamics of a spacecraft, and the principles which drive the design of an attitude determination and control subsystem. In particular, in the first part of the course the student acquires the fundamentals of attitude representation and dynamics. In the second part, he/she learns the algorithms and sensors which are employed for estimating the attitude, together with the algorithms and actuators for its control.

Obiettivi inglese: During the course, the student learns how to model and analyze the attitude dynamics of a spacecraft, and the principles which drive the design of an attitude determination and control subsystem. In particular, in the first part of the course the student acquires the fundamentals of attitude representation and dynamics. In the second part, he/she learns the algorithms and sensors which are employed for estimating the attitude, together with the algorithms and actuators for its control.

6704 000 000 B4005 - 0 - SPACECRAFT DEEP SPACE NAVIGATION ING-IND/05 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: The student learns in detail the techniques to perform the navigation of an artificial satellite outside the Earth orbit, from the cis-lunar to the deep space environment. The first part of the course focuses on the orbit determination process, used to estimate the past trajectory of a spacecraft from a set of measurements. In the second part, the main strategies to correct the deviations from the reference trajectory are explained. The theoretical framework is complemented by real-world examples and practical exercises using tracking data from past and ongoing deep space missions.

Obiettivi inglese: The student learns in detail the techniques to perform the navigation of an artificial satellite outside the Earth orbit, from the cis-lunar to the deep space environment. The first part of the course focuses on the orbit determination process, used to estimate the past trajectory of a spacecraft from a set of measurements. In the second part, the main strategies to correct the deviations from the reference trajectory are explained. The theoretical framework is complemented by real-world examples and practical exercises using tracking data from past and ongoing deep space missions.

6704 B79 000 77956 - 0 - SPACECRAFT SUBSYSTEMS AND SPACE MISSION DESIGN ING-IND/05 6 60/0/0/0 No Voto

Ambito: 1008 - A scelta dello studente D

Obiettivi: In the course, the students are introduced to the fundamentals of space systems engineering and the key aspects of spacecraft systems design. He/she will also learn the design considerations which come into play in laying out a space mission and its preliminary design. The students, take on a real-world problem and in a step-by-step and assignment driven approach, design a space mission that can provide the solution. They are exposed to the trade-off between performance, cost and schedule in a typical space mission design.

Obiettivi inglese: In the course, the students are introduced to the fundamentals of space systems engineering and the key aspects of spacecraft systems design. He/she will also learn the design considerations which come into play in laying out a space mission and its preliminary design. The students, take on a real-world problem and in a step-by-step and assignment driven approach, design a space mission that can provide the solution. They are exposed to the trade-off between performance, cost and schedule in a typical space mission design.

Gruppo: Final project

TAF: Ambito:

Cfu min: 24 Cfu max: 24

Note: Students must select the activities of one of the two groups up to 24 cfu.

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.

Final project (24 cfu) 0-24

6704 B79 000 30800 - 0 - FINAL PROJECT 24 0/0/0/0 No

Ambito: 1018 - Per la prova finale E

Obiettivi: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

Obiettivi inglese: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

Final project (6 + 18 cfu) 0-24

6704 B79 000 35500 - 0 - FINAL PROJECT 6 0/0/0/0 No

Ambito: 1018 - Per la prova finale E

Obiettivi: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

Obiettivi inglese: The students must be able to independently develop a research subject in one of the key areas characterising the study program, to prepare a written report and to defend it orally, demonstrating the achievement of the course learning objectives.

6704 B79 000 90779 - 0 - INTERNSHIP FOR PREPARATION FOR THE FINAL PROJECT 18 0/0/450/0 No Giudizio

Ambito: 1018 - Per la prova finale E

Obiettivi: At the end of the internship in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

Obiettivi inglese: At the end of the internship in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

6704 B79 000 93851 - 0 - INTERNSHIP FOR PREPARATION OF THE FINAL PROJECT ABROAD 18 0/0/450/0 No Giudizio

Ambito: 1018 - Per la prova finale E

Obiettivi: At the end of the internship abroad in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

Obiettivi inglese: At the end of the internship abroad in preparation for the final project, the student acquires knowledge in a range of professional fields through participation in practical activities and experiences, either at external structures or in university facilities, within the topic chosen for the final project.
In addition, the student can interact with different professional figures and work in a team; he/she develops communication skills, shows independent judgment, knows how to interpret technical reports drafted by collaborators or supervisors, knows how to draw up reports on the activities carried out within the topic chosen for the final project.

6704 B79 000 93852 - 0 - PREPARATION OF THE FINAL PROJECT ABROAD 18 0/0/450/0 No Giudizio

Ambito: 1018 - Per la prova finale E

Obiettivi: Students interested in theses of larger complexity extend their basic knowledge through extensive literature research and the study of topics not explicitly addressed in courses that are part of their curriculum. The student, guided by a professor and included in a major project carried out abroad, collaborates with the structured staff for the preparation of the university final project.

Obiettivi inglese: Students interested in theses of larger complexity extend their basic knowledge through extensive literature research and the study of topics not explicitly addressed in courses that are part of their curriculum. The student, guided by a professor and included in a major project carried out abroad, collaborates with the structured staff for the preparation of the university final project.

Gruppo: Internship - 6 cfu

TAF: F Ambito: 1146 - Tirocini formativi e di orientamento

Cfu min: 6 Cfu max: 6

Note: Student must select one of the two internship.
All the students which carry out activities in a Laboratory of the University of Bologna MUST follow the Health and Safety Training in Work-Places.
This training is made up of three parts: the first two are online, the third is delivered as a lesson (in presence or on the Teams platform).
Information can be found at the page “Health And Safety In Workplaces – Training Courses For Students”, in the section Studying / Teaching Activities of the web site of your course degree

Attività formativa	TIP	SSD	TAF	CFU	ORE F/E/L/N	FREQ.	VER.
6704 B79 000 71137 - 0 - INTERNSHIP				6	0/0/150/0	No	Giudizio
Ambito: 1146 - Tirocini formativi e di orientamento			F				

Obiettivi: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program.

Obiettivi inglese: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program.

6704 B79 000 85319 - 0 - INTERNSHIP ABROAD				6	0/0/150/0	No	Giudizio
Ambito: 1146 - Tirocini formativi e di orientamento			F				

Obiettivi: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program in a foreign company/university/laboratory/institution.

Obiettivi inglese: The student acquires direct knowledge of professional fields through participation in engineering activities consistent with the educational objectives of the study program in a foreign company/university/laboratory/institution.

Legenda:

CFU: crediti formativi universitari
TAF: tipologia attività formativa (A-di base; B-caratterizzanti; C-affini o integrative; F-ulteriori attività formative; D-a scelta autonoma dello studente; S- stages e tirocini presso imprese, enti pubblici o privati, ordini professionali; E-per la prova finale)
SSD: settore scientifico disciplinare
F/E/L/N: indica le ore Frontali/Esercitazioni/Laboratori/Ore di esercitazione e/o laboratorio tenute da non docenti
Freq.: segnala l'esistenza di un obbligo di frequenza
Ver.: indica la modalità di verifica del profitto finale
TIP.: indica la tipologia delle forme didattiche. Queste possono essere CON: convenzionali, E-L: in e-learning, MIX: miste, C/E: convenzionali e/o e-learning. Il corso di studio può definire annualmente una delle modalità.