Imperial College London

Programme Specification (Undergraduate)

MEng Aeronautics with Spacecraft Engineering

This document provides a definitive record of the main features of the programme and the learning outcomes that a typical student may reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities provided. This programme specification is intended as a reference point for prospective students, current students, external examiners and academic and support staff involved in delivering the programme and enabling student development and achievement.

Programme Information				
Award(s)	MEng			
Programme Title	Aeronautics with Spacecraft Engineering			
Programme Code	H415			
Awarding Institution	Imperial College London			
Teaching Institution	Imperial College London			
Faculty	Faculty of Engineering			
Department	Department of Aeronautics			
Associateship	City and Guilds of London Institute (ACGI)			
Main Location of Study	South Kensington Campus			
Mode and Period of Study	4 academic years, full-time			
Cohort Entry Points	Annually in October			
Relevant QAA Benchmark Statement(s) and/or other external reference points	Honours Degrees in Engineering and Master's Degrees in Engineering			
Total Credits	ECTS:	240-247	CATS:	480-494
FHEQ Level	Level 7			
EHEA Level	2nd cycle			
External Accreditor(s)	Royal Aeronautical Society (RAeS) Accreditation received: 2015 Accreditation renewal: 2020 Institute of Mechanical Engineers (IMechE) Accreditation received: 2015 Accreditation renewal: 2020			
Specification Details				
Student cohorts covered by specification	2016-17 entry to 2018-19 entry			
Person responsible for the specification	Dr Errikos Levis, Programme Leader			

Date of introduction of programme	September 2016
Date of programme specification/revision	March 2019

Programme Overview

All Aeronautical Engineering students cover the same core study programme for the first two years. This focuses on a broad base of physical and engineering subjects, including a strong emphasis on mathematics in the first year and an opportunity to attend a one-day flight testing course at the National Flying Laboratory Centre at Cranfield University in the second year.

The third year introduces specialised space-related material, including core modules in spacecraft structures and spacecraft systems. A broad selection of optional modules gives students the chance to tap into cutting-edge aeronautics research activities being undertaken by internationally recognised experts within the Department. In the summer term students carry out a six-week group design project. Working in design teams, students are tasked with developing a particular design concept to the stage where feasibility has been fully explored. Projects in recent years have included designing a manned mission to Mars, a horizontal launch vehicle for small payloads, "flying wing" passenger aircraft, and electric racing vehicles.

Study reaches Master's level in the fourth year, with further core modules relating to the design of spacecraft technologies and a choice of research-led modules. Students complete a four-month space-related research project, which gives them the chance to put their project management skills to the test. This can be carried out in the Department, in industry or at a research establishment, under the supervision of both College and industrial supervisors. Students who have studied the appropriate foreign language also have the opportunity to undertake their project in Europe.

The department maintains very close contact with industry through a joint academic-industry advisory board that was specifically constituted to provide input to the structure and syllabus of the programme. Contact between students and industry occurs through talks and seminars, specific lecture courses, and projects.

Learning Outcomes

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial College degree programme. The Graduate Attributes are available at: www.imperial.ac.uk/students/academic-support/graduate-attributes

Underpinning science, mathematics and associated engineering disciplines

US1 Knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, to enable appreciation of its scientific and engineering context, and to support their understanding of historical, current and future developments and technologies.

US1m A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US2 Knowledge and understanding of mathematical principles necessary to underpin their education in engineering discipline and to enable them to apply mathematical methods, tools and notations proficiently in the analysis and solution of engineering problems.

US2m An awareness of developing technologies related to own specialisation.

US3 Ability to apply and integrate knowledge and understand of other engineering disciplines to support study of their own engineering discipline.

US3m A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.

US4m An understanding of concepts from a range of areas including some outside engineering, and the ability to apply them effectively in engineering projects.

Engineering Analysis

EA1 Understanding of engineering principles and the ability to apply them to analyse key engineering processes.

EA1m Ability to use fundamental knowledge to investigate new and emerging technologies.

EA2 Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques.

EA2m Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

EA3 Ability to apply quantitative methods and computer software relevant to the engineering discipline, in order to solve engineering problems.

EA3m Ability to extract data pertinent to an unfamiliar problem, and apply in its solution using computer based engineering tools when appropriate.

EA4 Understanding of and ability to apply a systems approach to engineering problems and to work with uncertainty.

Design

D1 Investigate and define a problem and identify constraints including environmental and sustainability limitation, health and safety and risk assessment issues.

D1m Wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations.

D2 Understand customer and user needs and the importance of considerations such as aesthetics.

D2m Ability to generate an innovative design for products, systems, components or processes to fulfil new needs.

D3 Identify and manage cost drivers.

D4 Use creativity to establish innovative solutions.

D5 Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal.

D6 Manage the design process and evaluate outcomes.

Economic, social, and environmental context

S1 Knowledge and understanding of commercial and economic context of engineering processes.

S1m Extensive knowledge and understanding of management and business practices, and their limitations, and how these may be applied appropriately.

S2 Knowledge of management techniques which may be used to achieve engineering objectives within that context.

S2m The ability to make general evaluations of commercial risks through some understanding of the basis of such risks.

S3 Understanding of the requirement for engineering activities to promote sustainable development.

S4 Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk).

S5 Understanding of the need for a high level of professional and ethical conduct in engineering.

Engineering Practice

P1 Knowledge of characteristics of particular materials, equipment, processes, or products.

P1m A thorough understanding of current practice and its limitations, and some appreciation of likely new developments.
P2 Workshop and laboratory skills.
P2m Extensive knowledge and understand of a wide range of engineering materials and components
P3 Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology development, etc.)
P3m Ability to apply engineering techniques taking account of a range of commercial and industrial constraints.
P4 Understanding use of technical literature and other information sources.
P5 Awareness of nature of intellectual property and contractual issues
P6 Awareness of appropriate codes of practice and industry standards.
P7 Awareness of quality issues.
P8 Ability to work with technical uncertainty.

Intellectual Skills

1. Perform analysis and, thereby, solve problems in specific areas shown above
2. Integrate theory and practice in dealing with problems which involve several of the subject areas shown above
3. Carry out a synthesis/design of a process when faced with a conflicting set of objectives which are, to some extent, mutually exclusive
4. Demonstrate the skills necessary to plan, conduct and report a programme of original research or, alternatively, a project of direct and immediate industrial relevance.

Practical Skills

1. Plan and execute safely a series of experiments
2. Use laboratory methods to generate data
3. Analyse experimental results and determine their accuracy, precision, and validity
4. Prepare technical reports
5. Give technical presentations
6. Use effectively a wide range of computational tools and packages of a general nature
7. Use effectively a wide range of computational tools and packages relating specifically to the relevant engineering discipline being studied and to determine the range of their validity
8. Make use of knowledge from a number of diverse areas to synthesise a feasible solution to a complex problem of design

Professional Skills Development

1. Communicate effectively through oral presentations and written reports
2. Use Information and Communications Technology
3. Develop management skills: group coordination, decision processes, objective criteria, problem definition, project design and evaluation needs
4. Work as a team and/or independently, as appropriate
5. Be adequately prepared to enter a chosen sector of industry as a professional
6. Become aware of the environmental, economic and social impact of the specific engineering discipline being studied
7. Integrate and evaluate information from a variety of sources
8. Learn effectively for the purpose of continuing professional development.

Entry Requirements

Internal transfer only from H401 programme at the end of the second year. Transfer requirements **to be confirmed.**	
The programme's competency standards document can be found at: http://www.imperial.ac.uk/engineering/departments/aeronautics/study/ug/current/	
Learning & Teaching Strategy	
Scheduled Learning & Teaching Methods	• Lectures • Tutorials • Associated Problems Sessions
E-learning & Blended Learning Methods	• Blackboard VLE
Project and Placement Learning Methods	• Research Project • Industrial Internship Project
Assessment Strategy	
Assessment Methods	• Written Examinations • Coursework • Tutorial Material • Oral Presentations • Progress Reports
Academic Feedback Policy	

Feedback is an essential part of learning and the Department gives high priority to the timeliness and quality of assessment/feedback to students on all modules. The primary purpose of feedback is to assist learning and the development of skills, by highlighting strengths and weaknesses on one hand, and by identifying actions for improvement on the other. It is important to recognize that:

- Feedback comes in various forms;
- Feedback requires student active engagement.

The various forms of feedback we undertake are:

- Unstructured - for example, from fellow students in group work, or perhaps via dialogue with a lecturer or teacher in or outside of a tutorial, class or laboratory, or by email;
- More structured - for example, via the assessment of practical, laboratory, coursework or project submissions;
- Formal - via progress tests (examinable and non-examinable) or examinations;
- Scheduled surgery sessions for coursework and laboratories (for 2nd 3rd/4th labs only) after marking to explain the criteria used in assessment, common errors made, where marks are lost etc.

All coursework is submitted/marked and feedback-given via Blackboard. Every module has a dedicated "Feedback Forum" in Blackboard to provide an additional space and a historical repository for Question &

Answers.

Re-sit Policy

In line with College policy, students who are unsuccessful in any of their examinations may usually be allowed an opportunity to re-sit at the discretion of the Board of Examiners.

Students in the Faculty of Engineering who have marginally failed a year may be offered the chance to undertake a Supplementary Qualifying Test (SQT) at the discretion of the Board of Examiners in order to progress into the next year.

The College's Policy on Examination Re-sits and SQTs is available at:
https://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Further information regarding re-sits for BEng, MEng, BSc and MSci degrees in the Faculty of Engineering can be found in the relevant Academic Regulations available at:
https://www.imperial.ac.uk/about/governance/academic-governance/regulations/

Mitigating Circumstances Policy

Students may be eligible to apply for mitigation if they have suffered from serious and unforeseen circumstances during the course of their studies that have adversely affected their ability to complete an assessment task and/or their performance in a piece of assessment.

The College's Policy on Mitigating Circumstances is available at:
https://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Assessment Dates & Deadlines	
Year One	
Written Examinations	January, May and June
Coursework Assessments	Continuous
Project Deadlines	N/A
Practical Assessments	Continuous
Year Two	
Written Examinations	January, May and June
Coursework Assessments	Continuous
Project Deadlines	N/A
Practical Assessments	Continuous
Year Three	

Written Examinations	January, May and June
Coursework Assessments	Continuous
Project Deadlines	N/A
Practical Assessments	Continuous
Year Four	
Written Examinations	January, May and June
Coursework Assessments	Continuous
Project Deadlines	N/A
Practical Assessments	Continuous

Assessment Structure

Rules of Progression

Year One:

A student must:
Achieve a minimum mark of 40% in each individual examination;
Achieve a minimum aggregate mark of 40% overall for the examinations;
Achieve a minimum aggregate mark of 40% in the combined coursework assessments.

Supplementary qualifying tests (SQTs), in up to two modules, may be offered to candidates whose performance in Part I is marginally unsatisfactory.

Year Two:

A student must:
Achieve a minimum mark of 40% in each individual examination;
Achieve a minimum aggregate mark of 40% overall for the examinations;
Achieve a minimum aggregate mark of 40% in the combined coursework assessments.

Supplementary qualifying tests (SQTs), in up to two modules, may be offered to candidates whose performance in Part II is marginally unsatisfactory.

Year Three:

A student must:
Achieve a minimum mark of 40% in each individual core course examination;
Achieve a minimum aggregate mark of 40% for the examinations;
Achieve a minimum aggregate mark of 40% in the combined coursework assessments.

Supplementary qualifying tests (SQTs), in up to two modules, may be offered to candidates whose performance in Part III is marginally unsatisfactory.

Year Four:

A student must:
Achieve a minimum aggregate mark of 40% overall;
Achieve a minimum aggregate mark of 40% in the final year project.

Final year students are not allowed to repeat the year.

Marking Scheme

Final Degree Classifications

Third – a student must achieve an aggregate mark of 40%
Lower Second – a student must achieve an aggregate mark of 50%
Upper Second – a student must achieve an aggregate mark of 60%
First - a student must achieve an aggregate mark of 70%

Module Weightings			
Year	**% Year Weighting**	**Module**	**% Module Weighting**
Year One	11.1%	Introduction to Aerodynamics	9.11%
		Aircraft Performance	4.13%
		Computing	8.8%
		Engineering Design	4.6%
		Management and Business for Aeronautical Engineers	8.82%
		Properties of Materials	8.82%
		Mathematics	13.24%
		Mechanics	13.24%
		Introduction to Structural Analysis	8.82%
		Thermodynamics	8.82%
		Engineering Ethics	1%
		Experimental Methods (5 Labs)	6%
		L1 Applications	4.6%
Year Two	22.2%	Aerodynamics	9.29%
		Numerical Analysis	6.19%
		Manufacturing Processes	4.94%
		Circuits, Signals and Systems	9.29%
		Materials	6.19%
		Mathematics	9.29%
		Mechanics of flight	6.19%
		Propulsion and Turbomachinery	6.19%
		Structural Mechanics and Dynamics	9.29%
		Experimental Methods (8 Labs)	14.58%
		L2 Applications	9.29%

Module Weightings			
Year	**% Year Weighting**	**Module**	**% Module Weighting**
Year Two	22.2%	Technology, Business and the Market for Aeronautical Engineers	9.29%
Year Three	33.3%	Aircraft Aerodynamics	12.5%
		Finite Elements	8.33%
		Aircraft Structures	12.5%
		Aerospace Vehicle Design	16.68%
		Group Design Project	25%
		Spacecraft Structures	8.33%
		Spacecraft Systems	8.33%
		Control Systems	8.33%
Year Four	33.3%	Aerothermodynamics of launchers and re-entry vehicles	8.33%
		Structural Dynamics	8.33%
		Individual Project	58.35%
		3 x modules from elective group (A/B)	8.33% each

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	% Written Exam	% Course-work	% Practical	FHEQ Level	ECTS
AE1-101	Introduction to Aerodynamics	CORE	1	30	82.5	0	112.5	100%	0%	0%	4	4.5
AE1-102	Aircraft Performance	CORE	1	15	35	0	50	100%	0%	0%	4	2
AE1-103	Computing	CORE	1	41	84	0	125	0%	100%	0%	4	5
AE1-104	Engineering Design	CORE	1	48	27	0	75	0	100%	0%	4	3
AE1-116	Management and Business for Aeronautical Engineers	CORE	1	20	130	0	150	100%	0%	0%	4	6
AE1-106	Properties of Materials	CORE	1	24	101	0	125	100%	0%	0%	4	5
AE1-107	Mathematics	CORE	1	64	286	0	350	100%	0%	0%	4	14
AE1-109	Mechanics	CORE	1	36	64	0	100	100%	0%	0%	4	4
AE1-110	Introduction to Structural Analysis	CORE	1	30	70	0	100	100%	0%	0%	4	4
AE1-111	Thermodynamics	CORE	1	31	94	0	125	100%	0%	0%	4	5
AE1-112	Engineering Ethics	CORE	1	4	8.5	0	12.5	0%	100%	0%	4	0.5
AE1-113	Experimental Methods (5 Labs)	CORE	1	20	80	0	100	0%	100%	0%	4	4
AE1-114	L1 Applications	CORE	1	22	53	0	75	0%	100%	0%	4	3
AE2-201	Aerodynamics	CORE	2	40	135	0	175	100%	0%	0%	5	7

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	% Written Exam	% Course-work	% Practical	FHEQ Level	ECTS
AE2-202	Numerical Analysis	CORE	2	32	68	0	100	0%	100%	0%	5	4
AE2-203	Manufacturing Processes	CORE	2	16	46.5	0	62.5	0%	100%	0%	5	2
AE2-205	Circuits, Signals and Systems	CORE	2	36	126.5	0	162.5	90%	10%	0%	5	6
AE2-208	Materials	CORE	2	26	124	0	150	100%	0%	0%	5	6
AE2-209	Mathematics	CORE	2	75	175	0	250	100%	0%	0%	5	10
AE2-211	Mechanics of Flight	CORE	2	26	74	0	100	100%	0%	0%	5	4
AE2-212	Propulsion and Turbomachinery	CORE	2	25	75	0	100	100%	0%	0%	5	4
AE2-213	Structural Mechanics and Dynamics	CORE	2	2	40	122.5	162.5	100%	0%	0%	0%	6.5
AE2-214	Experimental Methods (8 Labs)	CORE	2	12	13	0	25	0%	100%	0%	5	1
AE2-215	L2 Applications	CORE	2	30	32.5	0	62.5	0%	100%	0%	5	2.5
AE2-216	Technology, Business and the Market for Aeronautical Engineers	CORE	2	20	130	0	150	100%	0%	0%	5	6
AE3-301	Aircraft Aerodynamics	CORE	3	40	147.5	0	187.5	80%	20%	0%	6	7.5
AE3-302	Control Systems	CORE	3	24	101	0	125	65%	25%	0%	6	5
AE3-303	Finite Elements	CORE	3	25	100	0	125	90%	10%	0%	6	5

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	% Written Exam	% Course-work	% Practical	FHEQ Level	ECTS
AE3-304	Aircraft Structures	CORE	3	40	147.5	0	187.5	80%	20%	0%	6	7.5
AE3-306	Group Design Project	CORE	3	20	355	0	375	0%	100%	0%	6	15
AE3-403	Aerospace Vehicle Design	CORE	3	20	230	0	250	0%	100%	0%	6	10
AE3-451	Spacecraft Systems	CORE	3	25	100	0	125	100%	0%	0%	6	5
AE3-452	Spacecraft Structures	CORE	3	25	100	0	125	100%	0%	0%	6	5
AEM-AAE02	Aircraft Systems Engineering and Aerial Vehicle Technologies	ELECTIVE (A)	3	24	101	0	125	85%	15%	0%	6	5
BE4-MBMX	Biomechanics	ELECTIVE (A)	3	28	122	0	150	95%	5%	0%	6	6
EE4-29	Optimisation	ELECTIVE (A)	3	25	100	0	125	100%	0%	0%	7	5
DE3-DLIE	Design-led Innovation and Enterprise	ELECTIVE (A)	3	31	119	0	150	0%	70%	30%	6	6
AE3-402	Separated Flows and Fluid-Structure Interaction	ELECTIVE (A)	3	24	101	0	125	100%	0%	0%	6	5
AE3-410	Mathematics	ELECTIVE (A)	3	29	96	0	125	100%	0%	0%	6	5
AE3-416	Advanced Propulsion	ELECTIVE (A)	3	24	101	0	12	100%	0%	0%	6	5
AE3-422	High-Performance Computing	ELECTIVE (A)	3	20	105	0	125	0%	100%	0%	6	5

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	% Written Exam	% Course-work	% Practical	FHEQ Level	ECTS
AE3-401	Advanced Mechanics of Flight	ELECTIVE (A/B)	3/4	20	105	0	125	70%	30%	0%	6	5
AE3-408	Materials in Action	ELECTIVE (A/B)	3/4	25	100	0	125	100%	0%	0%	6	5
AE3-409	Materials Modelling	ELECTIVE (A/B)	3/4	20	105	0	125	100%	0%	0%	6	5
AE3-412	Introduction to Turbulence and Turbulence Modelling	ELECTIVE (A/B)	3/4	26	99	0	125	100%	0%	0%	6	5
AE3-414	Computational Fluid Dynamics	ELECTIVE (A/B)	3/4	26	99	0	125	70%	30%	0%	6	5
AE3-415	Computational Mechanics	ELECTIVE (A/B)	3/4	25	100	0	125	85%	15%	0%	6	5
AE3-420	Innovation Management	ELECTIVE (A/B)	3/4	20	105	0	125	100%	0%	0%	6	5
AE3-421	Advanced Manufacturing	ELECTIVE (A/B)	3/4	20	105	0	125	100%	0%	0%	6	5
N/A	Business for Professional Engineers & Scientists	ELECTIVE (A/B)	3/4	Various			150	Various			6	6
N/A	Horizons	ELECTIVE (A/B)	3/4	Various			150	Various			6	6
AE4-401	Applications of Fluid Dynamics	ELECTIVE (B)	4	30	95	0	125	100%	0%	0%	7	5
AE4-403	Structural Dynamics	CORE	4	28	97	0	125	100%	0%	0%	7	5
AE4-404	Applied Computational Aerodynamics	ELECTIVE (B)	4	26	99	0	125	90%	10%	0%	7	5

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	% Written Exam	% Course-work	% Practical	FHEQ Level	ECTS
AE4-406	Individual Project	CORE	4	0	750	0	750	10%	90%	0%	7	30
AE4-450	Aerothermodynamics of Launchers and Re-entry Vehicles	CORE	4	25	100	0	125	100%	0%	0%	7	5

Supporting Information
The Programme Handbook is available at: http://www.imperial.ac.uk/aeronautics/study/ug/courses/
The Module Handbook is available at: http://www.imperial.ac.uk/aeronautics/study/ug/courses/
The College's entry requirements for undergraduate programmes can be found at: www.imperial.ac.uk/study/ug/apply/requirements/
The College's Quality & Enhancement Framework is available at: www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance
The College's Academic and Examination Regulations can be found at: http://www.imperial.ac.uk/about/governance/academic-governance/regulations/
Imperial College is an independent corporation whose legal status derives from a Royal Charter granted under Letters Patent in 1907. In 2007 a Supplemental Charter and Statutes was granted by HM Queen Elizabeth II. This Supplemental Charter, which came into force on the date of the College's Centenary, 8th July 2007, established the College as a University with the name and style of "The Imperial College of Science, Technology and Medicine". http://www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/
Imperial College London is regulated by the Office for Students (OfS) https://www.officeforstudents.org.uk/