

**Master of Engineering Degrees**  
in  
**Aeronautical Engineering**

**M.Eng.**

**M.Eng. with European Studies**

**M.Eng. with Industrial Project**

**Department of Aerospace Engineering**

**University of Glasgow**

## **Summary**

This document contains a description of the Master of Engineering degrees in Aeronautical Engineering by the Department of Aerospace Engineering, University of Glasgow. Three programmes are included: M.Eng., M.Eng. with European Studies and M.Eng. with Industrial Project. All three programmes have been designed to be compliant with the objectives of SARTOR 3, the route to accreditation outlined by the Engineering Council. In addition all the programmes have passed successfully through all the required approval stages of the University.

An overview of the department and its existing degree programmes is provided, which is then followed by the driving philosophy behind the M.Eng. degrees and their aims and objectives. The programme structures, and in particular the design themes within the programme, are then described, and an outline of the courses within the programme is given. The document finally describes the programme regulations.

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## **1. Introduction and background**

### **1.1 Overview of the Department of Aerospace Engineering**

The Department of Aerospace Engineering, University of Glasgow, is the sole provider of degrees in Aeronautical Engineering in Scotland. It therefore enjoys a unique position in the Scottish higher education sector. There are currently some 250 undergraduate students between first and fifth year level studying for the B.Eng. (Honours) and M.Eng. degrees and the B.Sc. (Ordinary) degree in Aeronautical Engineering. There are fourteen full time academic staff, an administrator, three secretaries and eight technicians. The Department is based in the James Watt (South) building on the main campus of the University. The Department's main undergraduate facilities are based here, although students attend lectures all over the university campus.

Graduates of the Department find employment in a wide range of disciplines. The majority pursue further research or gain employment in the aerospace sector and its related fields. Also a significant number choose to concentrate upon IT and finance, where the analytical skills of the engineering graduate are well regarded. With the current high profile of the aerospace sector in the UK manufacturing base, the global nature of the industry and the high technology image of aeronautical engineering, it is anticipated that the Department of Aerospace Engineering should be able to maintain a healthy intake of high quality school leavers. A key feature of the Departmental strategy regarding its undergraduate courses is therefore to continuously develop the programme to reflect new trends in the aerospace industry and new requirements set by the accrediting bodies.

### **1.2 Recent history of degree programmes offered**

For a number of years now, the majority of students have been studying on the B.Eng. (Hons) Aeronautical Engineering degree programme. This is a four year course, and up until the 1998 intake the programme has been accredited to chartered status by both the Royal Aeronautical Society (R.AeS.) and the Institute of Mechanical Engineers (I.Mech.E). The European M.Eng. programme, also fully accredited, has been running for ten years. This comprises a programme of study broadly similar to the B.Eng. with the addition of a fifth year, which is spent partly in industry and partly in a university in continental Europe. Students are invited to study for the European M.Eng. depending upon satisfactory performance at third year level. The B.Sc. (Ordinary) degree has been accredited to incorporated status by the above bodies. In general this degree is awarded to those who do not meet the progress criteria for the B.Eng. degree, subject to obtaining a minimum level of course credits, although students who do not progress satisfactorily through the 4th year of the B.Eng. may well be awarded the B.Sc. degree.

### **1.3 Philosophy of new M.Eng. degrees**

The primary motivation behind the new M.Eng. degrees is to provide degree programmes that are fully accredited under SARTOR by the R.Ae.S. Accreditation is a seal of approval valuable to a potential employer, and to produce graduates 'ready for industry' the Department must offer fully accredited degrees. The purpose of the B.Eng. degree has to be presented in comparison; the B.Eng. degree will produce graduates with the broad range of knowledge and skills appropriate for them to pursue a career as a professional engineer if they wish. The knowledge of the M.Eng. graduate, on the other hand, should be of greater breadth and depth than the B.Eng. graduate, and the level of individual and team project work should be noticeably greater. Also the M.Eng. graduate should have a greater awareness of economic and management issues in engineering. This could be achieved via taught courses or by designing project work so that the project management aspect would comprise a significant part of the project. All these factors comprise the guiding philosophies

of the M.Eng. curricula, and the necessary features have been incorporated into the programmes.

#### **1.4 Aims and objectives of M.Eng. degree programmes**

The aims and objectives of the M.Eng. degree programmes indicate the intentions of the staff conducting the courses comprising the programme and the consequent abilities of the graduate at the end of the programme respectively. These should both reflect the philosophy guiding the design of the curricula. The primary aim of the staff of the Department of Aerospace Engineering is thus to produce graduates in Aeronautical Engineering who will become successful, professional engineers in the aerospace industry. The M.Eng. graduate will therefore need to have acquired a range and depth of knowledge and a set of skills that will not only start the graduate on a career as a professional engineer in the aerospace industry, but will also be useful throughout their career.

Individual *aims* of the staff are as follows:

- Motivate the students to pursue a career in the aerospace industry
- Present a significant intellectual challenge that will stimulate the students' learning
- Set the general area of engineering science in the context of problem solving in aerospace engineering
- Present aerospace engineering as a multi-disciplinary, high technology theme
- Present a wide range of themes relevant to all areas of contemporary aerospace engineering
- Provide the opportunity for team working in aerospace design problems
- Provide the opportunity for creative input to aerospace design problems
- Provide the experience of advanced tools and techniques useful to the professional aerospace engineer
- Encourage the students to develop effective written and oral communication skills
- Encourage the students to apply their initiative
- Communicate a positive image of the aerospace engineer's role in society and raise the esteem of the professional engineer

For the M.Eng. with European Studies the aims are also to:

- Provide the opportunity for high-level study in a university in Continental Europe
- Provide the opportunity for the student to directly experience aerospace engineering in an international context

For the M.Eng. with Industrial Project the aims are also to:

- Provide the student with direct experience of the aerospace engineering industry
- Encourage the student to acquire additional skills directly from highly experienced, professional engineers

Individual *objectives* are that during the programme the graduate will have:

- Demonstrated considerable intellectual excellence in the field of engineering science
- Demonstrated a high level of interest in aeronautics and aerospace
- Successfully applied general engineering principles to a wide range of aerospace engineering problems
- Produced effective reports and delivered competent oral presentations
- Shown the ability to work effectively in a team
- Worked successfully and productively on representative aerospace design problems
- Gained familiarity with the design cycle in aerospace engineering problems
- Gained an appreciation of the state-of-the-art in aerospace engineering
- Demonstrated competence in the use of advanced tools and techniques in the analysis and solution of aerospace engineering problems

For the M.Eng. with European Studies the graduate will also have:

- Transferred his/ her skills successfully to a new environment and made a useful contribution to a group research effort in a contemporary theme in aerospace engineering
- Integrated seamlessly with a new group of peers
- Demonstrated a wider appreciation of working practices in Continental Europe

For the M.Eng. with Industrial Project the graduate will also have:

- Transferred his/ her skills successfully to an industrial environment
- Integrated seamlessly with an existing team of professional engineers
- Have made a useful contribution to an on-going industrial problem in aerospace engineering

The remainder of this document describes the M.Eng. curricula in more detail.

## 2. M.Eng. degree programme structures

### 2.1 Programme descriptions

For convenience the three M.Eng. curricula are described together. The differences will be emphasised where necessary, otherwise it may be assumed that that the particular description applies to all three curricula.

#### 2.1.1 Overview

The progression of a student through the M.Eng. curricula is indicated diagrammatically in figure 1. Students will normally enter the programmes at first year level. In exceptional circumstances a student may enter at second year level, however. Depending upon the performance at third year level, the student is permitted to progress onto their desired M.Eng. route starting year 4, otherwise the student follows the B.Eng. curriculum. Note that selection after year 2 would not be at the appropriate academic level. The standard, European and Industrial curricula follow slightly different paths at level 4. Provided the student progresses satisfactorily during year 4, the student finishes the M.Eng. by continuing on their chosen curriculum during year 5.

The courses comprising the curricula are indicated on figures 2a (years 1-3), 2b (year 4) and 2c (year 5). There are 8 identified themes appropriate for an aeronautical engineering degree: mathematics; structures; dynamics and control; fluid mechanics and aerodynamics; thermodynamics and propulsion; design; instrumentation, systems and electronics; business and management. These themes are each established in the first year and then built on as the degree course progresses. Figure 3 indicates how each course fits into the above themes; note an additional theme included on figure 3 is project work. As well as courses fundamental to these basic themes, a range of other specialist courses are available to the students to widen their knowledge. For example there are courses in industrial aerodynamics, spacecraft dynamics, rotorcraft, experimental aerodynamics and flight testing. Design remains, however, the element present in each year, which combines and applies the knowledge gained in the other courses to practical aeronautical design problems.

A more detailed description of the programme on a year by year basis follows. The reader may wish to follow figures 1 and 2.

#### 2.1.2 Year 1

The First Year of the course is an introductory year to provide a basic experience of engineering; academic work, design, and engineering skills are all included. The formal lecture courses provide a foundation in physics and mathematics together with an introduction to the engineering topics of statics, dynamics, thermodynamics and fluid mechanics. In these subjects there is scope for discussion of problems of relevance to Aerospace Engineering. There are formal tutorials associated with these courses, and assessment is by written exams. Time tabled laboratories attached to the physics and engineering courses demonstrate the basic principles. The physics laboratory forms part of the assessment of that course, and this provides the opportunity for log-book and report preparation. A separate, examinable course provides a basic introduction to the aircraft, its operating principle, and the factors affecting its performance and operation. Design, communication and computing skills are developed within the course Engineering Skills 1. Students perform a team design and build exercise of a simple balsa wood glider. Following a short lecture series that introduces the basic principles of aircraft design, the students design and build their aircraft during supervised laboratory sessions. Each team consists of approximately four students, and there is a competitive element to the exercise, which is based upon the weight and cost of the final aircraft and the distance that it flies from a

controlled launch. The communications element of Engineering Skills 1 involves lectures and laboratories in engineering drawing and other aspects of graphical communication. Each student must obtain the University's Basic Certificate in Information Technology, which indicates a basic familiarity with the computer and the use of e-mail and the world-wide-web. Further computing courses cover word processing and spreadsheet experience, while the Pascal programming language is used to provide the basics of computer programming. Experience of economics issues is gained via the course Structure of Industry 1. This course raises fundamental questions regarding modern industry in the UK.

### **2.1.3 Year 2**

In the Second Year of the course the introductory theme of First Year is still in place, although the level of the work is higher. Lecture courses in thermodynamics, fluid mechanics, statics, dynamics, materials and electronics develop the basic principles, while separate mathematics courses are aimed at the appropriate level. The opportunity is taken within these courses to examine problems of relevance to Aerospace Engineering. As with First Year, the lecture courses are supplemented with formal tutorials and laboratories; laboratories may be simulation based, as in dynamics, or experimentation using hardware may take place, as in fluid mechanics, propulsion, materials and electronics. Laboratory assessment is either by log-book or written report, and therefore communication skills are developed. The course Introduction to Aerodynamics 2 is designed to foster the students' interest in aeronautics, by providing a course dedicated to various issues affecting aircraft design, performance and operation. Real-world economic issues of relevance to the professional engineer are discussed in a service taught economics course.

As with First Year, the basic technical skills required by the engineering graduate are developed in a separate course, in this case Engineering Skills 2. More advanced computing (again using Pascal) is introduced, and the techniques are applied to an aeronautical case study (for example the cooling of a turbine blade). Additional lectures in this course cover material such as CAD and workshop practice, and there is a practical element that involves fortnightly workshop sessions at a local college where basic measurement, metal forming, machining and CAD/ CNC techniques are applied.

Finally a Second Year design project maintains the design theme introduced in First Year. To develop team skills the students conduct their project in groups of approximately four. The groups of students are allocated to different staff members, each of whom will set their own design problems; this will introduce a diverse range of topics, which will stimulate the students' interests. Typical projects include: the conceptual design of a future attack helicopter; the feasibility of a gyroplane for the martian atmosphere; issues regarding the certification of Concorde; the design of a wind tunnel experiment for third year undergraduates. Each student in the group is allocated a different role (for example group manager), and group meetings are overseen by the project supervisor. The project assessment is by formal report, oral presentation, poster presentation and log-book.

### **2.1.4 Year 3**

After the first two years of the course, students are able to tackle more demanding problems with an aeronautical theme, and therefore the Third Year of the course contains a stronger aeronautical emphasis than the previous two years. The basic principles relevant to aeronautics are covered by courses such as Aerodynamics and Fluid Mechanics 3, Dynamics and Control 3, Propulsion and Turbomachinery 3, Aircraft Structures & Materials 3 and Aerospace Instrumentation 3. As with Second Year each of these courses has a laboratory associated task: these include wind tunnel testing of wings and bluff bodies, flow visualization, gas turbine and propeller testing, measurement of the dynamic response of a spring/ damper system, and measurement of the stress distribution in a thin plate.

Mathematics teaching now focuses on numerical methods with a formal teaching course supplemented by computational exercises based on practical aerospace problems (solution of systems of nonlinear algebraic equations illustrated by the aircraft trim problem, for example). The course Flight Mechanics and Performance 3 introduces flight mechanics and flight testing. Laboratory programmes associated with this course include a weight-and-balance test of a gyroplane. The academic work is formally examined, and the laboratories are assessed by a combination of written reports and log-books. In the Third Year the students also select an additional subject from a list of options. The list currently includes technical subjects (Space Flight Dynamics; Industrial Aerodynamics; and Informatics) and non-technical ones (Financial Management; French and German), which allows for a diversification of interests. More subjects could be added according to staff availability and course demand.

The design element of the course revolves around the course Aerospace Design Project 3. A number of design exercises will take place, which will reflect the needs of the aerospace industry. The design activity will be based upon an introduction to conceptual design for performance and an aspect of structural design to close the design loop. For example the exercise may involve a study of how an existing aircraft might be fitted with new engines. The performance enhancements would have to be considered (take-off, climb, cruise, landing etc together with range) together with the modifications to the aircraft structure to accommodate the new engines. New themes will be introduced over the years. The project will be run as a group exercise, and the assessment will develop various technical communication skills.

#### **2.1.5 Year 4**

Students are invited to study for the M.Eng. Degree if they achieve a suitable level of performance in Third Year. Unsatisfactory performance will result in the student continuing with the B.Eng. Degree programme. The reader should refer to section 4 for the progress regulations. Successful B.Eng. students graduate at the end of year 4.

The lecture courses taken by 4th Year M.Eng. and 4th Year B.Eng. students are broadly similar. These are short, 10 credit courses covering Flight Dynamics, Fluid Mechanics, High Speed Aerodynamics, Aerospace Structures and Aeroelasticity & Vibration. Furthermore the Flight Testing course includes the week-long in-flight experiments course in the NFTL (Cranfield) operated Handley-Page Jetstream. This course is compulsory for all M.Eng. students, which reflects the need for greater breadth for the M.Eng. graduate. Two additional subjects are chosen from a list of options. This list reflects the research interests of the staff responsible for the courses and comprises Space Flight Dynamics, Computational Fluid Dynamics, Rotorcraft Aeromechanics, Avionics Systems and Lasers and Electro-Optic Systems. Students also take an introductory law course, Foundations in Law, which is intended to widen the M.Eng. student's awareness of management issues. The management course Managerial & Organisational Context E1 is offered as an option for those who want to pursue a more management oriented course.

M.Eng. students have three options for their final year (5th year) project: it can take the traditional form of an individual project based on the research expertise within the Department, a project within one of a number of a European Universities with which the Department has collaborative links, or through a UK industrial placement. This choice is made at the start of 4th year, as students choosing to study abroad will be required to take an appropriate language course, and students choosing to do the industrial placement may require specific skills. Those pursuing the 'standard' curriculum will conduct a limited scale research project in 4th year, in which the study is directed towards the main thrust of the project to be conducted in the 5th year. Overall, therefore, the combined 4th and 5th year project will be much more ambitious and wider in scope than the more traditional B.Eng. final

year project, as it will take place over a longer time duration which will allow the work to mature more. In year 4 the standard M.Eng. project will comprise an extensive literature review. Any rig design work or code development will take place as necessary and initial investigations can be made. Crucially, the student will then have responsibility for planning the research for the fifth year. Although all project students are expected to manage their work, this formal planning and preparation elevates the management aspect of the project to a much higher and more visible level appropriate to the M.Eng. graduate. Students on the 'industrial' curriculum will focus on developing specific, transferable skills in preparation for their 5th year industrial project. A key feature of industry is the ability to work to a plan on time and on cost, and therefore projects will be planned out for this group of students, which they must work to. Where possible the plan will have been formulated with the assistance of an industrial partner of the Department. Finally 'European' M.Eng. students must be given the opportunity to develop research skills to an appropriate level. This will be done via a set of library and computing exercises so that they will have developed transferable skills in preparation for their fifth year project. All M.Eng. students will have their projects assessed by report, log-book, oral presentation and their performance through the year.

All 4th year students take the group design course Aerospace Design Project 4. There are two elements to the project, namely an aerodynamics design exercise and a structural design exercise associated with the aerodynamic design. At this level the aerodynamics aspect might for example consider basic stability and performance considerations, and ESDU and DATCOM data sheets would be used, for example, to size a tail plane. This particular exercise would be presented in the context of an aircraft stretch, and therefore the economics are visible. The structural design associated with this aerodynamics exercise would examine aspects of the tailplane and fuselage structure to close the design loop. Within the groups, students take on specific roles. In both cases assessment is by written report and peer criticism.

### **2.1.6 Year 5**

M.Eng. students complete their study for their degree in year 5. As with the preceding four years, the course is a combination of academic work, project work and design work. Compulsory academic subjects include the study of Aeroelasticity, Aircraft Structures, Aircraft Handling Qualities & Control and Aircraft Operations & Systems. These build upon their fourth year counterparts or introduce new themes to create a greater breadth. To focus interest or broaden outlook, students also choose two topics from a list of options that currently comprises Spacecraft Systems, Turbomachinery and Experimental Aerodynamics. As with earlier years, this list will hopefully grow depending upon staff availability. There is a compulsory management course Professional Studies 4, and an elective course, Marketing Function 1 available to those wishing to obtain further management experience. All formal teaching will take place in the first semi-year (weeks 1 - 12) and exams will be scheduled for weeks 13 and 14.

The second semi-year (weeks 15 - 27) is reserved for project work. The 'standard' students do their group design exercise and continue with their individual project, while the 'industrial' and 'European' students conduct their project work at their industrial or European placements. The individual project work for the 'standard' students builds upon the foundation laid in year 4, and the topic of study is taken to a much higher level than would be expected of a B.Eng. student. The student will be required to display a high level of self-reliance and be able to act on his or her own initiative for the majority of the project. As with year 4 the project is research based, although a much higher level of understanding and discussion will be present. The project will be assessed by formal report, oral presentation and poster presentation.

The final design project of the course, Aerospace Design Project 5, brings together all the experience and knowledge gained during the preceding four years of study. It is only

included in the 'standard' curriculum. The project will consist of a detailed conceptual design of a nominated aircraft type. As with earlier years students in each group will assume a given role. Individual staff will act as consultants on the projects, and each group will be given a budget of consulting time. Assessment will be by report, poster, oral presentation by the group and peer criticism within the group.

The European placement will allow students to gain experience living and working in a foreign country. This should broaden their outlook and expose them to different methods and facilities than they would experience within their home Department. The Universities they are likely to visit include TU Munich, Delft and Politecnico di Torino. The project they will carry out will include an individual theme that will contribute to an overall group effort. This will ensure the continuation of group working within the curriculum, whilst permitting project work to be carried out at a high level.

The UK industrial placement has obvious advantages in that it will provide valuable industrial experience for the students. The Department has established many links in industry and placements are obtained every year for the existing M.Eng. Companies such as Rolls-Royce, GKN Westlands and BAE Systems as well as DERA Bedford, Farnborough and Boscombe Down have all provided places in the past. Students taking the industrial placement will form part of a team working on a project. The student must make a useful contribution to this project, and therefore successful teamwork is automatically part of the project.

## **2.2 Integration of design into programmes**

Design is a central theme throughout the five year M.Eng in Aeronautical Engineering. There is a specific design course, project or laboratory in each of the five years.

In first year, and for second year direct entrants, there is a design and build exercise (part of Engineering Skills 1) where teams of four students design, build and test a small model glider using design guidelines provided in the accompanying lecture course. This course aims to promote team working, and helps students to develop their skills in making fundamental design choices, working within guidelines, and using simple theory in a practical task. Important design lessons that may be gained from this course are making a design easy to manufacture and making compromises between conflicting design requirements (for example, the most efficient aerodynamic wing planform is also the most difficult to manufacture - students have to trade off efficiency with ease of manufacture).

In the second year, Aerospace Design Project 2 provides a more detailed group design task. Here, small teams of students are assigned rôles of manager, accountant and engineers to perform a design task suggested by one of the academics (two previous examples of tasks are conceptual design of a future battlefield helicopter, and design of a modification programme for Concorde to allow reinstatement of the aircraft's certificate of airworthiness). These group projects are designed to educate the teams of students in problem based learning, group task allocation, record keeping, research methods, and presentation skills.

The third year and fourth year design projects, Aerospace Design Project 3 and 4 are related to each other and are composite courses consisting of a lecture element pertinent to the structural design or performance and stability aspects of an aircraft configuration. The lectures seek to highlight important paradigms in aeronautical design and provide examples as an aid to understanding. In the fourth year course, guest speakers from industry provide examples of design projects within the industry. The aims of the third and fourth year design projects are to offer the students experience in working on a particular aircraft design project using fundamental engineering skills that they have attained during their lecture courses. In the third year the design project is based on the conceptual design of an aircraft and involves both designing for a specific performance and the structural consequences of the design/modification. An example project is an aircraft re-engining process, where the

students would have to choose the correct engine to meet performance specifications and then investigate the structural modifications that would be necessary for the new engine. In the fourth year design project, the process of design for static longitudinal stability is undertaken. One example of a fourth year group project is designing for static stability in response to an aircraft re-engine and/ fuselage stretch. In the fourth year, the projects are run in the context of an industry based design project and include a full input of commercial, marketing and quality requirements as well as design, analysis and project management. During the third and fourth year courses the students will build on their problem solving, team working, presentation, and management skills.

The fifth year design course, Aerospace Group Design Project 5, is the central design element of the final year of the M.Eng. in Aeronautical Engineering. The project builds on the design work carried out in previous years. The students are formed into groups representing various sectors of an aerospace design and manufacturing company (such as the aerodynamics office, structures and stress office etc.) and given a major aircraft design project. Successful completion of the task requires excellent communication between each of the groups and careful management. This management is provided by the academic staff of the department and a representative from each of the groups. The aim of the course is to foster an understanding of the relationships between different design functions, encourage team working and develop project management skills and encourage the application of the students current engineering knowledge to practical design.

Elements of the other aeronautical subjects are pertinent to design and feed into the design projects. For example, Introduction to Aerodynamics 2 describes designing wing sections using NACA profiles; Propulsion & turbomachinery 3 contains case studies in turbine design; and Flight Mechanics and Performance 3 discusses the implications of design features (such as the empennage layout) on the performance of aircraft. The structures courses in 3<sup>rd</sup> and 4<sup>th</sup> year contain a large proportion of structural design examples and the Aeroelasticity 4 and 5 courses contain case studies in designing rotor systems to avoid vibration and ground resonance and designing a wing to avoid flutter.

### **2.3 Relationships between courses**

Some courses are pre-requisites to courses in the following year. This relationship is shown diagrammatically in figure 4. Pre-requisite courses should be passed with a minimum grade D, while other courses should be passed with a minimum grade E. The reader should refer to section 3 for progress regulations.

## **3. Regulations**

### **3.1 Entry Requirements**

The entry requirements for SCE Higher and GCE A-Level are quoted in Table 1 for both 1<sup>st</sup> year entry and 2<sup>nd</sup> year direct entry. The 2<sup>nd</sup> year direct entry is to an accelerated M.Eng. programme lasting 4 years (see section 3.5).

Table 1: Entry Requirements

Qualification	1 <sup>st</sup> Year Entry	2 <sup>nd</sup> Year Direct Entry (Accelerated M.Eng.)
SCE Highers and Advanced Higher	Subjects at <b>ABBBC/ AABB</b> with A/ B pass in Maths and Physics or Engineering or Technological Studies. English higher required.	Advanced Higher passes at <b>BBB/ ABC</b> including Maths and Physics along with good Higher grades.
GCE A Levels	2 Passes at Grades <b>BB</b> to include Maths and normally physics or Engineering Science	Passes at Grades <b>ABC</b> including Maths and Physics or Engineering Science at <b>AB</b> or <b>BA</b> .

These are unchanged from the existing B.Eng. entry requirements, which is consistent with the philosophy that all entrants enrol initially on the B.Eng. programme. Further justification for maintaining entry requirements at their current level is the exceptionally high average point score achieved by entrants to the existing B.Eng. programme, Table 2.

Table 2 Average Point Score on Entry

Year	1997	1998	1999	2000
Average Entry Point Score	28.4	27	27.5	26.5

### 3.2 Progress

Progress regulations are based on achieving a required Grade Point Average and obtaining minimum levels of performance in each individual course. For courses which are prerequisites for courses later in the programme, a minimum of a D grade (an overall score in the range 40 - 49%) is required, whilst for all other courses an E grade (an overall score in the range 30 - 39%) is sufficient. The regulations for progress on a year to year basis are as follows.

#### Year 1

Automatic progression into year 2 requires the student to obtain:

- i) a Grade Point Average of at least 10,
- ii) at least a D grade in each prerequisite subject,
- iii) at least an E grade in all subjects.

Resit exams are available (August/September) to assist students in attaining these standards.

#### Year 2

Automatic progression into year 3 requires the student to obtain:

- i) a Grade Point Average of at least 10,
- ii) at least a D grade in each prerequisite subject,
- iii) at least an E grade in all subjects.

Again resit exams are available.

#### Year 3

Automatic progression into year 4 - M.Eng, requires the student to obtain:

- i) a Grade Point Average of at least 14,
- ii) at least a D grade in each prerequisite subject,
- iii) at least an E grade in all subjects.

Resit exams are available to obtain the appropriate GPA and individual grades for progression. It should however be noted that it is the exam weighted average mark from the first diet (May / June) which is normally used in future assessment of Honours grading. This is to discourage the practise of "strategic exam sitting", or indeed the unnecessary resitting of passed exams to obtain higher marks.

Note also that to progress into M.Eng. the entire third year block has to be attempted in one go.

#### Year 4

Automatic progression into year 5 - M.Eng, requires the student to obtain:

- i) a Grade Point Average of at least 12,
- ii) at least a D grade in each prerequisite subject,
- iii) at least an E grade in all subjects.

No resits will be available.

### **3.3 Award of Certificates, Diplomas and Degrees**

A range of qualifications may be awarded to students who fail to meet progress requirements, or who opt to graduate at an earlier stage.

- i) *Certificate of Higher Education (Engineering Studies)*

This award is conferred by the Faculty of Engineering to students obtaining 120 credits of an engineering course with a GPA greater than 8.5. It is rarely awarded and is usually for students leaving after 2 attempts to complete a first year.

- ii) *Diploma of Higher Education (Engineering Studies)*

Again, this award is conferred by the Faculty of Engineering this time students must have gained 240 credits with a GPA greater than 8.5. It is rarely awarded and is usually for students leaving having been unable to clear 2<sup>nd</sup> year after 3 years of study.

- iii) *Bachelor of Engineering Studies - BES*

This is a Faculty awarded degree aimed at students unable to reach the Ordinary Degree standard. Usually these are students who have studied for 4 years and been unable to collect appropriate credits or Grade Point Average to progress further. The main requirements are for 360 credits with a GPA of 10.

- iv) *Bachelor of Science - B.Sc. (Ord.)*

Students failing to reach the 4<sup>th</sup> year B.Eng. class fall back into the B.Sc. Ordinary class. These are usually students who failed to obtain D grades in one or more prerequisite subjects in 3<sup>rd</sup> year, or students who perhaps have taken 4 years to complete years 1 - 3 of the course. Principal requirements are for 420 credits to have been completed with a Grade Point Average of at least 10. The Department is not seeking accreditation for this degree.

v) *Bachelor of Engineering - B.Eng. (Hons)*

Students not attaining the necessary GPA to transfer to the M.Eng. programme will complete the B.Eng. in their 4<sup>th</sup> year. Note that some students with results enabling them to progress to the M.Eng. may opt, perhaps due to funding difficulties, to stay on the B.Eng. programme. To obtain the B.Eng., 560 credits are required, and the calculation for classification of this Degree is presented in section 3.4. For the Royal Aeronautical Society the Department is seeking that the B.Eng. will form a step towards accreditation with matching sections. for this degree. For details of the B.Eng. degree programme see section 4.

vi) *Master of Engineering - M.Eng. (Hons)*

Having obtained the necessary GPA and individual course grades, students continuing on the M.Eng. programme have to complete 680 credits as prescribed in Section 2, the calculation for classification of this Degree is presented in section 3.4. Students failing the 4<sup>th</sup> year of the M.Eng. programme will be awarded an B.Sc. Ordinary Degree. This is consistent with the regulations for the B.Eng. Degree. Students completing the 4<sup>th</sup> year successfully but deciding not to continue to 5<sup>th</sup> year will be asked to complete a project before being awarded a B.Eng. degree. Full accreditation of the M.Eng. degree is the ultimate aim of the department.

### 3.4 Honours Degree Classifications

A final Honours mark for the M.Eng. is obtained by the calculation shown below:

5 <sup>th</sup> Year	60%
4 <sup>th</sup> Year	40%

The mark for each year will be based upon the proportion of credit associated with each course in the curriculum. Therefore, for example, approximately 40% of the classification for the Standard and Industrial M.Eng. is based upon project and design work.

The final mark obtained is used to determine the Honours classification as shown in Table 3. A student scoring below 50% will be awarded a B.Eng. Honours degree, the classification of which is determined by consideration of 3<sup>rd</sup> year and 4<sup>th</sup> year marks and a composite project mark from the 4<sup>th</sup> and 5<sup>th</sup> year projects, the weightings being as for the B.Eng. degree described in section 4.

Table 3: M.Eng. Degree Classification

Score Range (%)	Honours Classification
70 - 100	1 <sup>st</sup> Class
60 - 69.9	2-1 (Upper) 2 <sup>nd</sup> Class
50 - 59.9	2-2 (Lower) 2 <sup>nd</sup> Class
0 - 49.9	B.Eng. (Hons)

Note that there is no 3<sup>rd</sup> class mark.

### 3.5 The accelerated M.Eng. programme

Students with exceptional entrance grades may start the degree programme in Second Year (see section 3.1). This category of students should already have the academic background to cover the level of the principles taught in first year, and it is more appropriate that they start in Second Year. A typical student would be one with exceptional 'A'-levels, Higher and Advanced Higher grades or a tertiary college qualification (e.g. HND). Before starting their study, this group of students will be issued with a starter pack that contains details of the curricula of the first year. Closer tutoring will be given to these students as well, in the form of regular, formal meetings with their adviser of studies or the programme co-ordinator. Other remedial activities will be developed as necessary; an observation has been made regarding deficiencies in statics (an element of Applied Mechanics 1 and 2) in this category of intake, for example, and closer tutoring by the course leader has been provided. In order that these students do not miss out on the essential skills, management awareness and design courses in the normal five year curriculum, however, their programme of study is slightly different in the first two years. This programme is indicated in figure 2a. In Second Year they take the course Engineering Skills 2A which includes all the elements of Engineering Skills 2 with the drawing and Design & Build exercise from Engineering Skills 1. In Third Year these students take the course Structure of Industry 1. The students are then judged to have 'caught up' with their peers.

### 4. The B.Eng. degree programme

A short description of the B.Eng. programme is included in the current document since the B.Eng. has been alluded to in the description of the M.Eng. programmes. All that is necessary is to show the courses comprising the B.Eng. programme. The existing B.Eng. programme has been forced to change as a result of the development of the M.Eng. programmes, and the changes to the B.Eng. curricula are being dealt with on a year by year basis using the relevant Senate/ Quality Assurance forms (MRP1). The courses comprising the (amended) B.Eng. degree for 1999 entrants are shown in figure 5. A comparison of this figure with figure 2 for the M.Eng. indicates that the fourth year B.Eng. and M.Eng. programmes differ in the type of individual project work. Furthermore the Flight Testing course is compulsory for M.Eng. students, but is an option for B.Eng. students. The B.Eng. graduate will have a smaller breadth and depth of knowledge than the M.Eng. graduate.

For comparison with the M.Eng., a final B.Eng. Honours mark is currently obtained by the calculation shown below:

4 <sup>th</sup> Year Exam Weighted Average	50%
4 <sup>th</sup> Year Project	20%
4 <sup>th</sup> Year Design Exercise	5%
3 <sup>rd</sup> Year Exam Weighted Average	25%

The final mark obtained is used to determine the Honours classification as shown in Table 4.

Table 4: B.Eng. Degree Classification

Score Range (%)	Honours Classification
70 - 100	1 <sup>st</sup> Class
60 - 69.9	2-1 (Upper) 2 <sup>nd</sup> Class
50 - 59.9	2-2 (Lower) 2 <sup>nd</sup> Class
40 - 49.9	3 <sup>rd</sup> Class
0 - 39.9	Ordinary

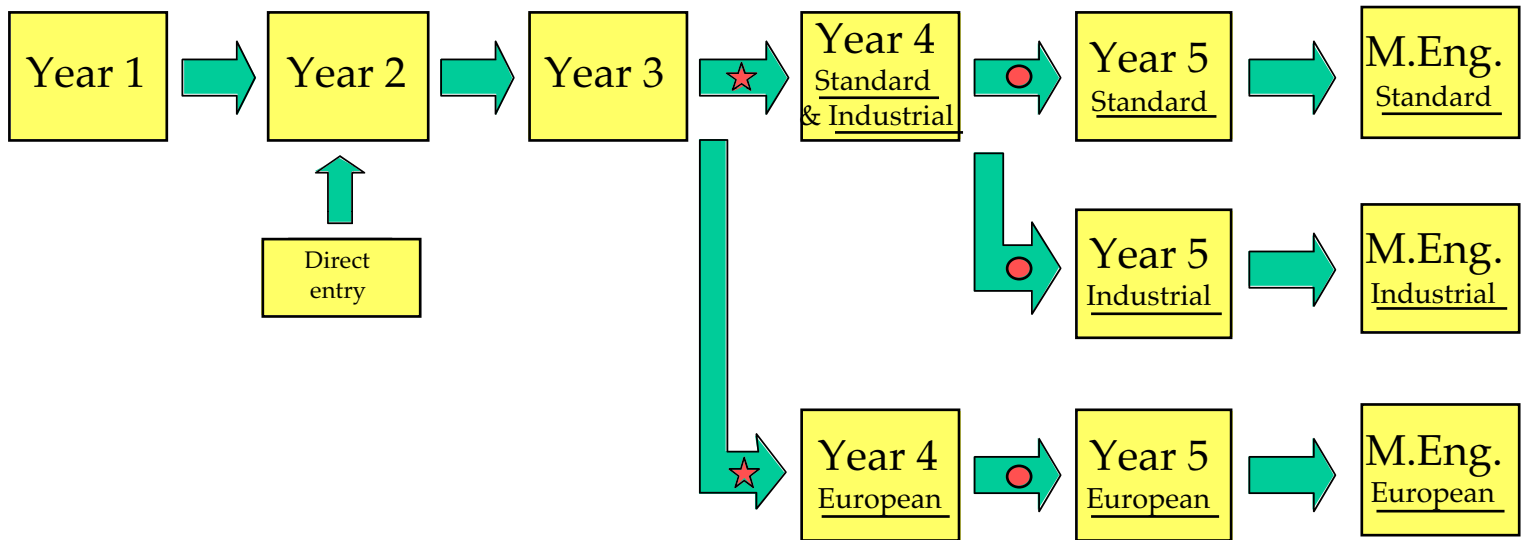
If every single student qualified to continue on the M.Eng. programme after third year decided actually to continue on the M.Eng., then it is anticipated that very few 1st class B.Eng. degrees would be awarded. This would be a natural consequence of the more capable students being creamed off into the M.Eng. together with the inclusion of the third year in the B.Eng. weighting. Note that the weighting of the design work in the B.Eng. final mark is small at 5%; it is significantly larger in the M.Eng. since the aims of that degree are different.

## 5. Conclusions

A structure for an M.Eng. degree programme in Aeronautical Engineering has been proposed. The course develops the identified core themes in Aeronautical Engineering, and optional subjects allow the student to develop an awareness of more specialized or wider issues. A significant amount of the assessment is based upon individual research project work and group based design project work.

## Figures

- Figure 1**      **Routes to M.Eng.**
- Figure 2a**    **Curriculum, years 1-3**
- Figure 2b**    **Curriculum, year 4 (130 credits in total)**
- Figure 2c**    **Curriculum, year 5 (130 credits in total)**
- Figure 3a**    **Course relationships: theme development by compulsory courses**
- Figure 3b**    **Course relationships: theme development by optional courses.**
- Figure 4**     **Course relationships: pre-requisite tree**
- Figure 5**     **B.Eng. degree programme**



**Figure 1**  
Routes to  
M.Eng.

★ Further progress on M.Eng. subject to performance above specified level in third year: (GPA of 14 or above, including at least HD in pre-requisites and at least HE in other subjects)

● Further progress on M.Eng. subject to performance above specified level in fourth year: (GPA of 12 or above, including at least HD in pre-requisites and at least HE in other subjects)

## Year 1

COURSE	CREDITS
Maths E1	40
Physics E1A	20
Thermofluids 1	20
Applied Mechanics 1	20
Engineering Skills 1	20
Aerospace Engineering 1	10
Structure of Industry 1	10
<b>total=140</b>	

## Year 2

COURSE	CREDITS
Maths E2A	20
Maths E2C	20
Thermofluids 2	20
Applied Mechanics 2	20
Engineering Skills 2	10
Introduction to Aerodynamics 2	10
Aerospace Design Project 2	10
Electrical Machines & Power 2*	10
Introduction to Engineering Materials 2	10
Macroeconomics E1	10
<b>total=140</b>	

## Year 3

COURSE	CREDITS
Aerodynamics & Fluid Mechanics 3*	20
Dynamics & Control 3	20
Flight Mechanics & Performance 3*	20
Aircraft Structures & Materials 3*	20
Aerospace Design Project 3*	20
Propulsion & Turbomachinery 3*	10
Aerospace Instrumentation & Measurement 3	10
Numerical Methods in Aerospace Engineering 3*	10
<b>subtotal=130</b>	

+

Optional courses: select one from List A	
Space Flight Dynamics 3	10
Industrial Aerodynamics 3	10
Aerospace Informatics 3	10
Managerial Accounting & Finance E1	20
French for Engineers 3	20
German for Engineers 3	20
<b>subtotal=10/ 20</b>	

**total=140/ 150**

Direct entry into second year	
Year 2: as normal except Engineering Skills 2A (20 credits) replaces Engineering Skills 2	150 credits
Year 3: as normal except select only 10 credit course from list A and add Structure of Industry 1 (10 credits)	150 credits

\* denotes new course

Figure 2a Curriculum, years 1-3

Figure 2b  
Curriculum, year 4 (130 credits in total)

**Basic curriculum**

COURSE	CREDITS
Aircraft Vibration & Aeroelasticity 4*	10
Flight Dynamics 4*	10
Physics of Fluids 4*	10
High Speed Aerodynamics 4*	10
Aircraft Structures & Materials 4*	10
Aerospace Design Project 4*	20
Flight Testing 4*	10
Foundations in Law E1*	10
subtotal=90	

*plus select*

*either*

**Standard Curriculum**

COURSE	CREDITS
Research Project 4*	20
Optional courses: Select subjects totalling 20 credits from list B	20
subtotal=40	

*or*

**Industrial Curriculum**

COURSE	CREDITS
Industrial Project 4*	20
Optional courses: Select subjects totalling 20 credits from list B	20
subtotal=40	

*or*

**European Curriculum**

COURSE	CREDITS
Language Course 4A	20
Research & Project Skills 4*	10
Optional courses: Select subjects totalling 10 credits from list B	10
subtotal=40	

List B	CREDITS
Space Flight Dynamics 4*	10
Computational Fluid Dynamics 4*	10
Rotorcraft Aeromechanics 4*	10
Lasers & Electro-Optical Systems M4	20
Avionics Systems 3	20
Managerial & Organisational Context E1	10

\* denotes new course

Figure 2c  
Curriculum, year 5 (130 credits in total)

**First half session**

COURSE	CREDITS
Aerospace Engineering 5 comprising:	
Aeroelasticity 5*	10
Aircraft Structures & Materials 5*	10
Aircraft Handling Qualities & Control 5*	10
Aircraft Operations & Systems 5*	10
Optional courses: select subjects totalling 20 credits from list C	20
	subtotal=60
	+
Management course:	
Professional Studies 4	10

List C	Credits
Space Craft Systems 5*	10
Rotodynamic Machinery 5	10
Experimental Aerodynamics 5*	10
Marketing Function E1	10

First half session  
subtotal=70

**Second half session**

**Standard curriculum**

COURSE	CREDITS
Aerospace Group Design Project 5*	30
Research Project 5*	30

**Industrial curriculum**

COURSE	CREDITS
Industrial Project A5*	60

**European curriculum**

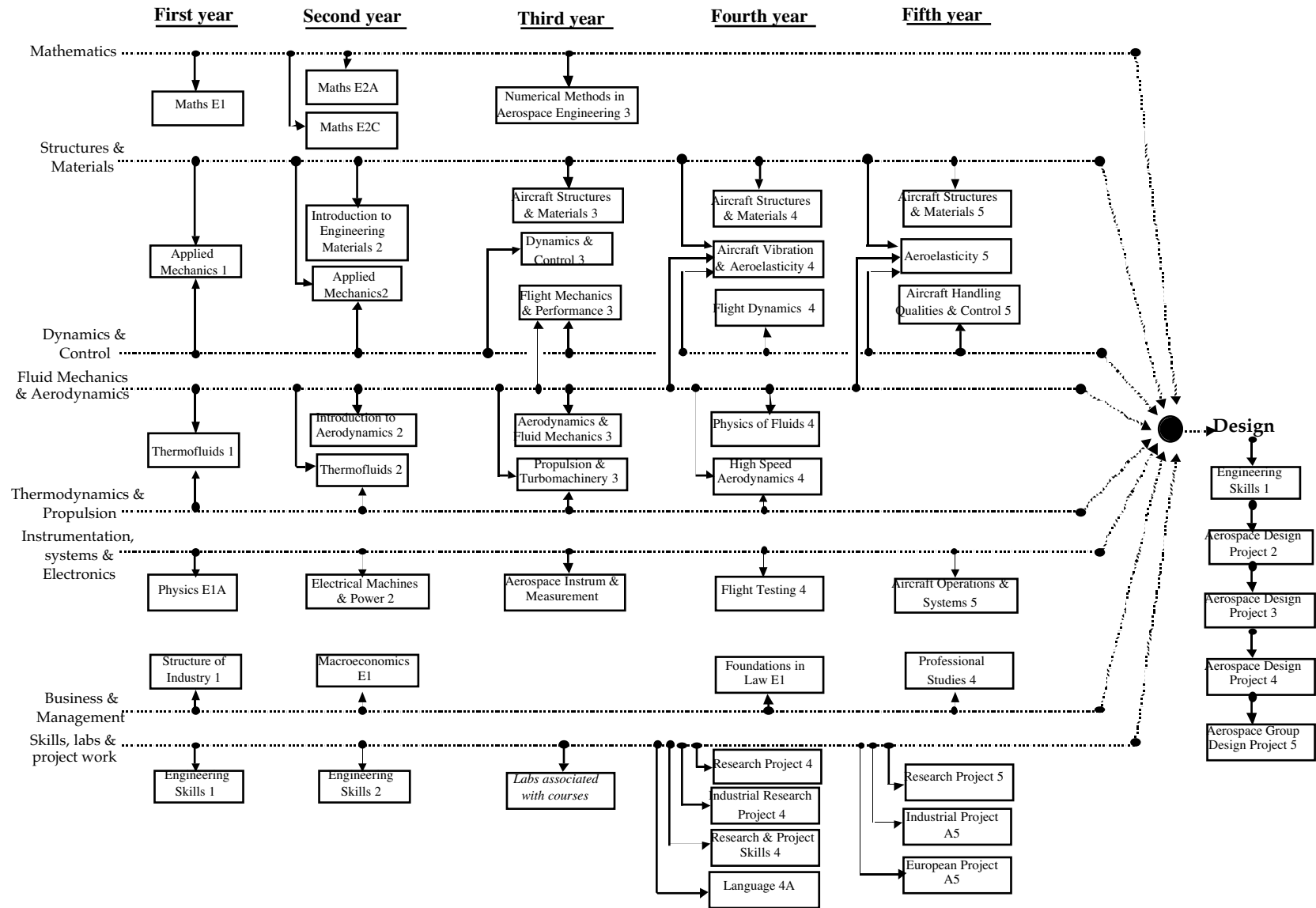
COURSE	CREDITS
European Project A5*	60

Second half session  
subtotal=60

**Total 130 credits**

\* denotes new course

## Theme development for M.Eng. in Aeronautical Engineering (compulsory courses)

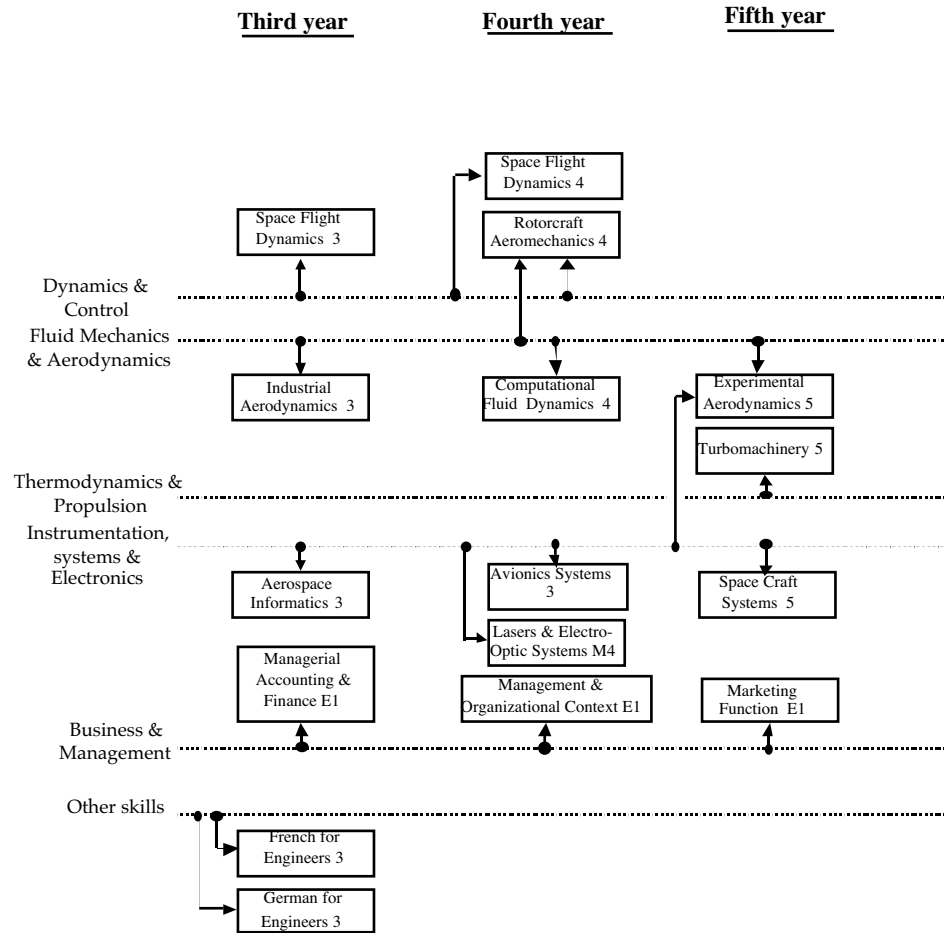


**Figure 3a Course relationships: theme development by compulsory courses**

Theme development for M.Eng. in Aeronautical Engineering (optional courses)

Figure 3b Course theme development by courses.

relationships:  
optional



# Pre-requisite tree for M.Eng. in Aeronautical Engineering

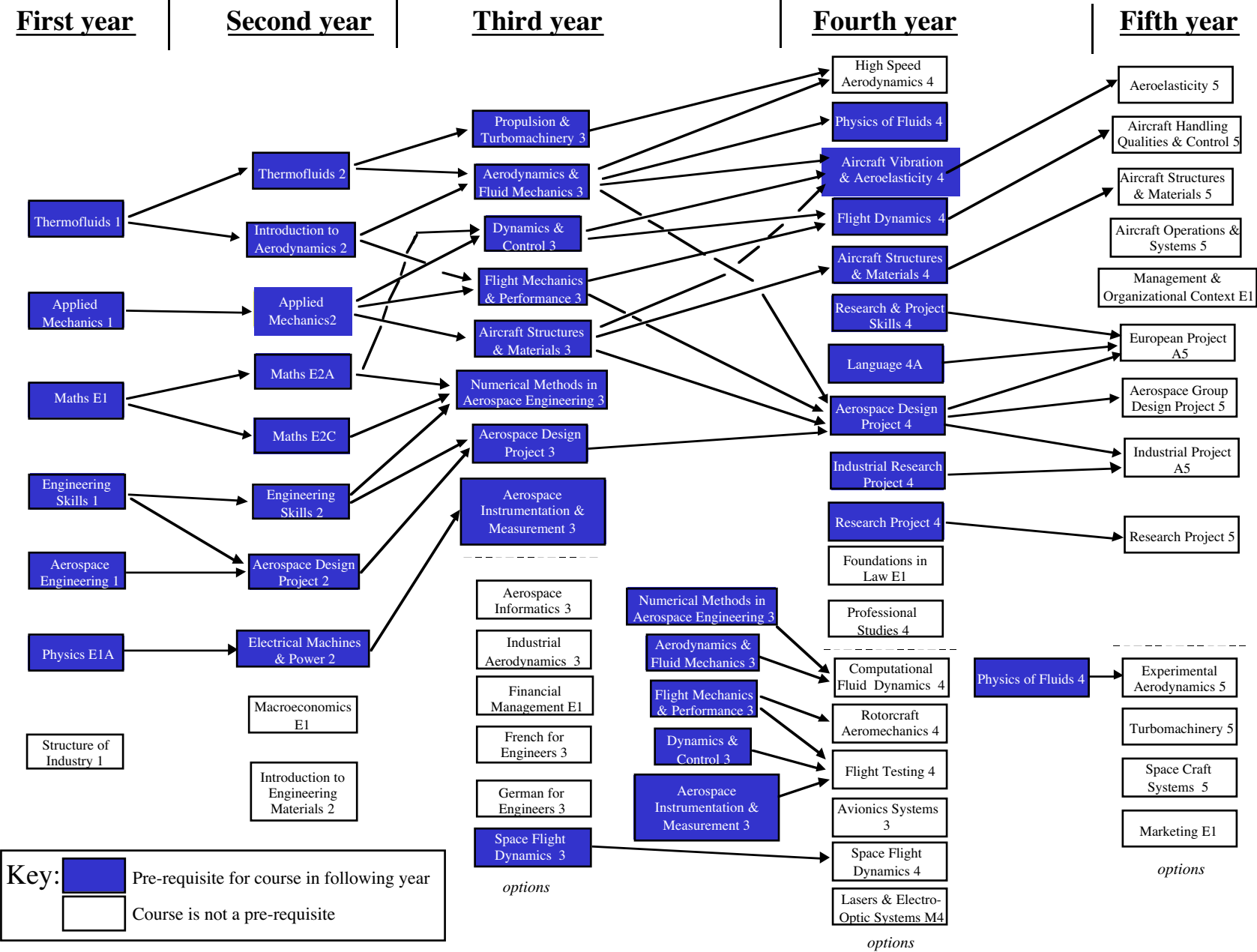


Figure 4 Course relationships: pre-requisite tree

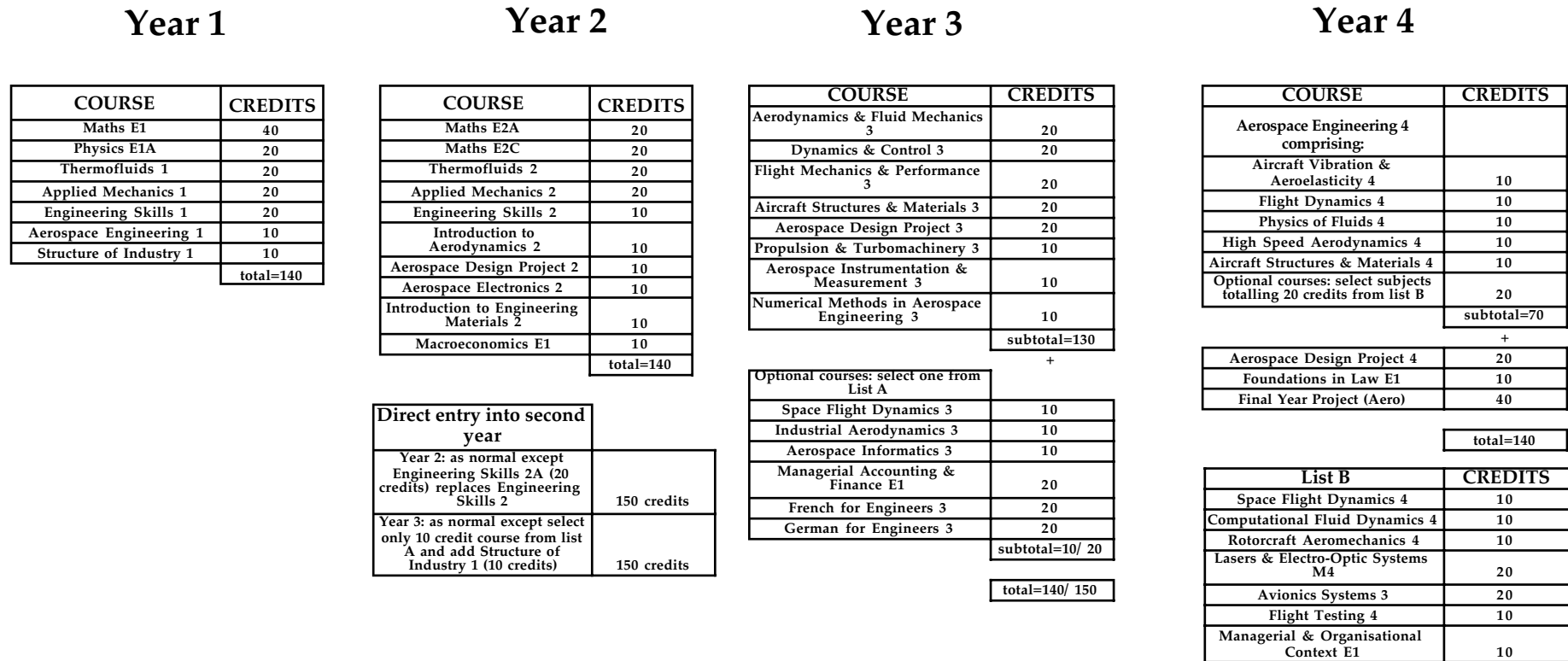


Figure 5 B.Eng. degree programme