Programme Specification 2018-19

ENGINEERING TRIPOS

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<th>Awarding body</th>
<th>University of Cambridge</th>
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<td>Teaching institution</td>
<td>Department of Engineering</td>
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<tr>
<td>Accreditation details</td>
<td>IET, IMechE, ICE, IMC, RAeS, IStructE, IHT, IPEM</td>
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<td>Name of final award</td>
<td>BA (Hons), MEng</td>
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<td>Programme title</td>
<td>Engineering Tripos</td>
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<tr>
<td>UCAS code</td>
<td>H100</td>
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<td>HECoS code(s)</td>
<td>100184 (general or integrated engineering)</td>
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<td>Relevant QAA benchmark statement(s)</td>
<td>Engineering</td>
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<td>Qualifications framework level</td>
<td>6 (Honours) (for the BA award)</td>
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<td>7 (Masters) (for the MEng award)</td>
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The following reference points were used in creating the Programme Specification:

- Subject benchmarking information for Engineering
- Requirements of Engineering Professional Institutions/Bodies

Educational Aims of the Programme

The Engineering Tripos is a four year course which is designed to produce graduates with both an unrivalled breadth of knowledge across the field of engineering and an in-depth knowledge of their chosen field of specialisation.

This is achieved through the unique course structure whereby students cover all the main disciplines of engineering during the first two years of the course and develop the analytical, design and computing skills that underpin modern engineering practice. This grounding enables students to make an informed choice about their area of specialisation for their third and fourth years, during which they will: engage with leading engineering research; hone their creative, critical thinking and transferable skills; and gain accreditation from the relevant professional engineering institution(s).

The skills and knowledge acquired through the programme produce highly versatile engineering graduates who work well in multidisciplinary teams and are equipped to play leading roles in industry, the professions, academia and public service.

The evolution of the programme is informed by the Department’s mission to produce ‘21st century engineers’, so new areas of teaching are developed in response to the advance of scholarship and the needs of the community.

The Department aims to continue to attract outstanding students, irrespective of race, background, gender or physical disability both from within the UK and from overseas.

Programme Outcomes

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas. The programme outcomes have reference to the Benchmark Statement for Engineering (E).
A. Knowledge and Understanding

1. Basic Mathematics and Physics that are relevant to engineering (E);
2. The fundamental concepts, principles and theories of Structural, Mechanical and Electrical engineering (E);
3. Business and management techniques that are relevant to engineering and engineers (E);
4. Detailed knowledge and understanding of the essential facts, concepts, principles and theories relevant to the student’s chosen area of specialisation (E);
5. The role of the engineers in society and the constraints within which their engineering judgement will be exercised (E);
6. The professional and ethical responsibilities of engineers (E);
7. The international role of the engineer and the impact of engineering solutions in a global context (E).

Teaching/learning methods and strategies

- Acquisition of 1 and 2 is through a combination of lectures, small group teaching (supervisions), examples classes, laboratory experiments, coursework and projects in years 1 and 2.
- Acquisition of 3 is through a combination of lectures, supervisions, coursework and projects throughout the course.
- Acquisition of 4 is through a combination of lectures, supervisions, laboratory experiments, coursework and projects in years 3 and 4.
- Acquisition of 5 and 6 is through lectures throughout the course and coursework (Engineering Area activities) in year 3.
- Acquisition of 7 is through a combination of lectures, small group classes, seminars, coursework and projects run directly or supported by the Language Programme for Engineers.

Throughout the learner is encouraged to undertake independent reading both to supplement and consolidate what is being taught/learnt and to broaden their individual knowledge and understanding of the subject.

Assessment

Testing of the knowledge base is through a combination of unseen written examinations (1-4) and assessed coursework (1-7) in the form of laboratory experiment write-ups (1, 2, 4), essays (3, 5-7), oral examinations (7), coursework reports (3-7) and project reports and presentations (2, 3, 4, 7).

B. Intellectual (thinking) skills - able to:

1. Plan, conduct and report a programme of original research;
2. Analyse and solve engineering problems (E);
3. Design a system, component or process to meet a need (E);
4. Be creative in the solution of problems and in the development of designs (E);
5. Formulate and test hypotheses;
6. Evaluate designs, processes and products, and make improvements (E);
7. Integrate and evaluate information and data from a variety of sources (E);
8. Take an holistic approach in solving problems and designing systems, applying professional judgements to balance risks, costs, benefits, safety, reliability, aesthetics and environmental impact (E).
Teaching/learning methods and strategies

- Intellectual skills are developed through the teaching and learning programme outlined above.
- Analysis and problem solving skills are further developed through examples papers (question sheets issued by course lecturers) and through supervisions (small group teaching).
- Experimental, research and design skills are further developed through coursework activities, laboratory experiments, and research and design projects. Individual feedback is given to students on all work produced.

Assessment

Analysis and problem solving skills are assessed through unseen written examinations. Experimental, research and design skills are assessed through laboratory experiment write-ups, coursework reports and project reports and presentations.

C. Practical skills - able to:

1. Plan and execute safely a series of experiments (E);
2. Use laboratory and workshop equipment to generate data (E);
3. Analyse experimental results and determine their strength and validity (E);
4. Prepare technical drawings;
5. Prepare technical reports;
6. Give technical presentations;
7. Use the scientific literature effectively;
8. Take notes effectively;
9. Write computer programs;
10. Use computational tools and packages (E).

Teaching/learning methods and strategies

- Practical skills are developed through the teaching and learning programme outlined above.
- Practical experimental skills (1-3) are developed through laboratory experiments and project work.
- Skill 4 is taught through lectures and developed through drawing coursework exercises and project work.
- Skills 5 and 6 are taught through Exposition classes in year 1 and then developed through feedback on reports written and presentations made as part of coursework assignments.
- Skill 7 is developed through research project work.
- Skill 8 is taught through a Study Skills session held at the start of the course and through the regular review of project log books.
- Skill 9 is taught through lectures and developed through computing coursework exercises.
- Skill 10 is taught and developed through coursework exercises and project work.

Assessment

Practical skills are assessed through laboratory experiment write-ups, coursework reports and project reports and presentations. Individual feedback is given to students on all work produced.
D. Transferable skills - able to:

1. Communicate effectively (in writing, verbally and through drawings), also using more than one language (E);
2. Apply mathematical skills (algebra, geometry, modelling, analysis);
3. Work as a member of an interdisciplinary team (E);
4. Transfer techniques and solutions from one field of engineering to another (E);
5. Use Information and Communications Technology (E);
6. Manage resources and time (E);
7. Learn independently in familiar and unfamiliar situations with open-mindedness and in the spirit of critical enquiry (E);
8. Learn effectively for the purpose of continuing professional development and in a wider context throughout their career (E).

Teaching/learning methods and strategies

Transferable skills are developed through the teaching and learning programme outlined above. In addition, students are required to provide evidence of industrial experience.

- Skill 1 is taught through Exposition classes in year 1 and then developed through feedback on reports written, drawings produced and presentations made as part of coursework assignments.
- Skills 2 and 4 taught through lectures and supervisions and developed throughout the course.
- Skill 3 is developed through group project work (especially the Integrated Design Project in year 2).
- Skill 5 is developed through laboratory experiments, projects and other coursework activities and individual learning.
- Skill 6 is introduced through a Study Skills session held at the start of the course and developed throughout the course.
- Although not explicitly taught, skills 7 and 8 are nurtured and developed throughout the course, which is structured and delivered in such a way as to promote this.
- The industrial experience provides evidence of skills 1, 3, 6, 8 and may develop others depending on the nature of the placement.

Assessment

Skill 1 is assessed through coursework exercises and reports, presentations and oral examinations. Skill 2 is assessed primarily through examinations. Skill 4 is assessed through examinations and through research project work. The other skills are not formally assessed.

Programme Structure

The programme is only offered as a full-time course. The course normally lasts for four years and leads at the end of the fourth year to the degrees B.A. (with honours) and M.Eng. All engineers take the same first year course (Part 1A), but there is an element of diversification towards the end of the second year (Part IB). This approach enables students to have a closer look at the options before they choose their specialization.

In the third year (Part IIA) students concentrate on their chosen branch of engineering. Strong specialization is possible in year four (Part IIB) when each student chooses 8 modules from about 70. It is possible for a student to leave the course after three years with
a BA Honours degree. However, the course is designed around a four-year structure and the student would be leaving his or her training unfinished.

**Year 1 (Part IA)**

All students take the same courses leading to four examinations at the end of their first year:
- *Mechanical Engineering* (covering Kinematics & Dynamics, Mechanical Vibrations and Thermofluid Mechanics);
- *Structures and Materials*;
- *Electrical & Information Engineering* (covering Physical Principles of Electronics, Linear Circuits & Devices, Electromagnetism, and Digital Circuits & Information Processing);

All lecture courses, other than *Mathematics* (but including *Computing*), have associated coursework exercises. A short lecture course in *Dimensional Analysis* also has associated coursework, and may be examined in any paper.

There are non-examined lecture courses in: *The Engineer in Society; Drawing; Principles of Design; Engineering Applications*. Of these courses, all but Engineering Applications have associated coursework activities.

Students also undertake extended coursework activities in *Exposition* (writing and presentation skills), *Microprocessors*, a *Lego Mindstorms Project*, an *Integrated Electrical Project* and a *Structural Design Project* (the three projects involving design-build-test).

Optional coursework activities in a *Foreign Language, Workshop Skills, Engine Strip & Rebuild* and *Computer Build* are available. All but the Engine Strip & Rebuild are also available in later years.

**Progression requirements**

Minimum of III class performance across the aggregate of all papers and coursework. Students failing to reach this standard may be allowed to progress if there are significant mitigating circumstances.

**Outcomes developed and assessed**

A1-3, A5-7, B2-5, B7-8, C2-6, C8-10, D1-2, D5-8.

**Year 2 (Part IB)**

All students study eight core subjects for the first two terms of their second year. These courses are: *Mechanics; Structures; Materials; Thermofluid Mechanics; Electrical Engineering; Information Engineering; Mathematical Methods; Introductory Business Economics*. Each of the first six courses has associated coursework, including the interdisciplinary *Integrated Coursework activity on Design of Earthquake-resistant Structures*. There is also a lecture course in *Sustainable Engineering*, with an associated coursework activity.

Students also undertake coursework exercises in *Computing* (C++ and Matlab), the *Integrated Coursework Project*, in which mechanical properties of materials are investigated, and the *Integrated Design Project*, a four-week competitive robot vehicle design-build-test project in teams of six.
The third term contains options (selected topics), one in each of the main professional engineering disciplines. Each student either chooses two topics or chooses one topic and offers coursework in a foreign language (French, German or Japanese). The selected topics available are: *Aerothermal Engineering* (Design of a Jet Engine); *Mechanical Engineering* (Renewable Energy Systems); *Civil and Structural Engineering* (Design and Construction of Underground Space); *Information Engineering* (Photo Editing & Image Searching); *Electrical Engineering* (Micro & Nano Electronic Devices); *Bioengineering* (Engineering Applied to the Living World); *Manufacture, Management & Design* (Bringing Technology Innovations to Market).

By the end of the second year, students must have undertaken 4 weeks of approved industrial experience.

**Progression requirements**
Minimum of III class performance across the aggregate of all papers and coursework. Students failing to reach this standard may be allowed to progress if there are significant mitigating circumstances.

**Outcomes developed and assessed**
A1-3, A5-7, B2-8, C2-6, C8-10, D1-3, D5-8.

**Year 3 (Part IIA)**
During the first two terms, students study 10 modules (with up to 16 lectures in each) of their choice. Students may choose to qualify in one or more Engineering Areas, in which case they must take a minimum number (usually six) from the list of modules associated with their chosen Engineering Area. Modules may be associated with more than one Engineering Area. Students are provided with lists detailing these associations and also restrictions on module choices to satisfy Institutional accreditation requirements. Students may choose to qualify in Engineering, in which case they may choose modules from any areas.

The available Engineering Areas (specialisations) are: *Mechanical Engineering; Energy, Sustainability and the Environment; Aerospace & Aerothermal Engineering; Civil, Structural & Environmental Engineering; Electrical & Electronic Engineering; Information & Computer Engineering; Electrical & Information Sciences; Instrumentation & Control; Bioengineering.*

Students also undertake a group activity associated with their chosen Engineering Area.

Most modules available have associated coursework activities. The modules on offer vary slightly from year to year, but a typical list is as follows:

- **Fluid Mechanics & Thermodynamics** - Fluid Mechanics I (double module); Fluid Mechanics II (double module); Thermodynamics and Power Generation; Heat and Mass Transfer.
- **Electrical Engineering** - Radio Frequency Electronics; Integrated Digital Electronics; Switch-Mode Electronics; Electric Drive Systems; Semiconductor Engineering; Photonic Technology.
- **Mechanical & Materials Engineering** - Materials Processing and Design; Dynamics; Vibration; Mechanics of Solids; Machine Design; Fracture Mechanics of Materials and Structures.
- **Civil, Structural & Environmental Engineering** - Geotechnical Engineering I; Geotechnical Engineering II; Structural Materials and Design; Structural Analysis and Stability; Water Engineering; Finite Element Methods; Building Physics and Environmental Geotechnics.
- **Management & Manufacturing** – Business Economics; Marketing; Modelling Risk; Human Resource Management; Organizational Behaviour; Operations Management for Engineers.
- **Information Engineering** - Signals and Systems; Systems and Control; Signal and Pattern Processing; Data Transmission; Computer and Network Systems; Software Engineering and Design.
- **Bioengineering** – Introduction to Molecular Bioengineering; Mathematical Physiology, Introduction to Neuroscience; Medical Imaging and 3-D Computer Graphics; Biomaterials.
- **Multidisciplinary Modules** – Mathematical Methods, Robotics.
- **Shared (with year 4) Modules** - Design Methods; Pre-Stressed Concrete; Partial Differential Equations and Variational Methods; Nuclear Power Engineering.

The third term consists of project work undertaken after the examinations. All students complete two projects, at least one of which must be a group activity. All students must complete at least one project with a design focus. Projects may involve elements of design, computing and fieldwork; there are also foreign language options.

By the end of the third year, students must have undertaken an additional 4 weeks of approved industrial experience.

**Progression requirements**
Completion of Part IIA can lead to the award of a BA (Hons). In order to proceed to Year 4 (Part IIB) and the award of the MEng, students must achieve a minimum of II.2 class performance across the aggregate of all papers and coursework, or III class performance if at least II.2 class performance was achieved in year 2.

**Outcomes developed/assessed**
Knowledge as indicated by course titles: Skills – B2-8, C1-10, D1-2, D4-8.

**Year 4 (Part IIB)**
Each student chooses eight modules from about 70, with a minimum number (usually four) from the list of modules associated with their chosen Engineering Area. The modules on offer vary slightly from year to year, but a typical list of modules (with up to 16 lectures in each) is given below. Modules may involve coursework for 0%, 25% or 100% of the module credit. Modules may be associated with more than one Engineering Area. Students are provided with lists detailing these associations and also restrictions on module choices to satisfy Institutional accreditation requirements.

A major project extends throughout the final year, and can be expected to occupy about half the student's time. This may involve some "blue-skies" research or have direct industrial application; both types of project can, and often do, involve collaboration with industry.

The modules on offer vary slightly from year to year, but a typical list is as follows:
- **Fluid Mechanics & Thermodynamics** - Computational Fluid Dynamics; Turbomachinery I; Aerodynamics; Molecular Thermodynamics; Flow Instability; Turbomachinery II; Turbulence and Vortex Dynamics; Combustion and IC Engines; Aeroacoustics.
- **Electrical Engineering** – Power Microelectronics; Nanotechnology; Solid State Devices and Chemical/Biological Sensors; VLSI Design, Technology and CAD; Photonic Systems; Electronic Systems and Instrumentation; Solar-electronic Power: Generation and Distribution; Renewable Electrical Power; Display Technology; Analogue Integrated Electronics.
• **Mechanics & Materials Engineering** – Designing with Composites; Electrical and Nano Materials; Design Methods; Design Case Studies; Advanced Linear Vibrations; Random and Non-linear Vibrations; Applications of Dynamics; Continuum Mechanics; Micro-Electro-Mechanical Systems (MEMS): Design; Advanced Machine Design.

• **Civil, Structural & Environmental Engineering** – Construction Engineering; Foundation Engineering; Dynamics in Civil Engineering; Concrete Structures; Pre-Stressed Concrete; Structural Steelwork; Architectural Engineering; Contaminated Land and Waste Containment; Sustainable Water Engineering; Plate and Shell Structures.

• **Management & Manufacturing** – Information Systems; Management of Technology; International Business Economics; Accounting and Finance; Strategic Management; Project Management.

• **Information Engineering** - Control System Design; Robust and Nonlinear Systems and Control; Optimal and Predictive Control; Advanced Communications and Coding; Digital Filters and Spectrum Estimation; Image Processing and Image Coding; Statistical Pattern Processing; Speech & Language Processing; Computer Vision and Robotics; Machine Learning.

• **Bioengineering** – Biosensors; Computational Neuroscience; Biomimetics; Molecular Modelling; Cellular and Molecular Biomechanics.

• **Imported Modules** (from other Cambridge courses) – Strategic Valuation; Nuclear Materials; Electricity and Environment; Medical Physics; Low Power Embedded Systems Programming; Nuclear Reactor Engineering; Advanced Fission and Fusion Systems.

• **Additional Topics** - French; German; Spanish; Japanese; Materials and Processes for Microsystems (MEMS); Surveying Field Course; Partial Differential Equations & Variational Methods; Sustainable Development; Sustainable Energy; Nuclear Power Engineering; Practical Optimization; Present and Future Energy Systems; Advanced Building Physics

**Award of the MEng**
The pass criterion for the M.Eng degree requires candidates to achieve a II.2 standard or better in both their project and their modules.

**Outcomes developed/assessed at this level include:**
Knowledge as indicated by course titles. Skills – B1-8, C1-10, D1-8.

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Every effort has been made to ensure the accuracy of the information in this programme specification. At the time of publication, the programme specification has been approved by the relevant Faculty Board (or equivalent). Programme specifications are reviewed annually, however, during the course of the academical year, any approved changes to the programme will be communicated to enrolled students through email notification or publication in the *Reporter*. The relevant faculty or department will endeavour to update the programme specification accordingly, and prior to the start of the next academical year.

Further information about specifications and an archive of programme specifications for all awards of the University is available online at: [https://www.camdata.admin.cam.ac.uk/](https://www.camdata.admin.cam.ac.uk/)