This is a four-year course overall. In the first year Chemical Engineering students read Part I A of the Engineering Tripos or the Natural Sciences Tripos. Students then read Part I of the Chemical Engineering Tripos in year two, Part IIA of the Chemical Engineering Tripos in year three, and Part IIB of the Chemical Engineering Tripos in year four. The Chemical Engineering Tripos is delivered by the Department of Chemical Engineering and Biotechnology.

Educational aims of Programme

The programme aims to:

(i) give a sound education in the fundamentals of Chemical Engineering;
(ii) develop the skills and confidence necessary for the solution, based on engineering and scientific principles, of problems in the chemical, biochemical and allied industries;
(iii) produce graduates of the highest calibre;
(iv) provide an education accredited by the Institution of Chemical Engineers.

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas. These are compiled with reference to the QAA benchmark statement on Engineering.

Knowledge and Understanding

The course aims to give graduates knowledge and understanding of:

- the essential facts, concepts, principles and theories of Chemical Engineering, and an understanding of the constraints within which engineering judgement must be exercised;
- basic mathematics, science and technology;
- ideas of management.

The course aims to give graduates an awareness and understanding of:

- professional and ethical responsibilities;
- the impact of engineering activities in a global and societal context;
- contemporary issues.
Intellectual Abilities

The course aims to give graduates the ability to:

- solve engineering problems, which may be underspecified, and which may involve limited and/or contradictory information;
- analyse and interpret data and, when necessary, design experiments to gain new data;
- design a process or plant item to meet a need;
- evaluate designs, processes and products, and make improvements;
- be in a position to implement new and advancing technology;
- take a holistic approach to engineering problems, taking into account professional judgement, cost, benefit, safety, quality, reliability, environmental impact;
- assess risks, and manage risks.

Practical Skills

The course aims to give graduates the ability to:

- use a wide range of techniques and equipment, including pertinent software;
- use laboratory and workshop equipment to generate data and to perform tests;
- develop, promote and apply safe systems of work.

General Transferable Skills

The course aims to give graduates the ability to:

- apply mathematical skills to practical problems;
- communicate effectively, both orally and in writing;
- use Information and Communication Technology effectively;
- manage time and resources;
- work in teams;
- be creative, particularly in design;
- be analytical in the formulation and solution of problems;
- extract information from published sources.

Programme structure

This is a four-year course overall. In the first year Chemical Engineering students read Part IA of the Engineering Tripos or the Natural Sciences Tripos. Entry after taking other first-year courses is possible if approved by the Chemical Engineering and Biotechnology Syndicate.

Students read Part I of the Chemical Engineering Tripos in year two, and Part IIA of the Chemical Engineering Tripos in year three. Part I and Part IIA form an integrated course in which students are introduced to Chemical Engineering and are taken to professional level in well-established areas of the discipline. The aim is to give students the background and the knowledge to deal with many problems in today's process industries.

Students read Part IIB Chemical Engineering Tripos in year four. The Part IIB course is intended to give students a deeper understanding of some fundamental subjects, to introduce them to a range of specialist areas of Chemical Engineering and Biotechnology, to give them an insight into the department's research activities, and to provide them with an opportunity to broaden their education. The aim is to prepare graduates for a lifetime of professional activity within the process industries or other sectors.
Progress from one year to the next is conditional on attaining a satisfactory standard.

**Part I**

A student who has gained honours in Part IA of the Engineering Tripos or Part IA of the Natural Sciences Tripos may take Chemical Engineering Tripos Part I. A student who has read another Tripos in the first year may apply to the Chemical Engineering and Biotechnology Syndicate to be given leave to take Chemical Engineering Part I.

In Part I students gain a broad exposure to the principal Chemical Engineering topics.

There are lecture courses on:
- Fundamentals: process calculations; fluid mechanics; heat and mass transfer fundamentals.
- Process Operations: separations; homogeneous reactors; biotechnology; heat and mass transfer operations.
- Process Systems: economics; safety, health and environment.
- Mathematics: engineering mathematics.
- Convergence Topics: mechanical engineering for those who read science in the first year; chemistry for those who read Engineering in the first year.

There are classes on:
- Computing: instruction is given on the solution of Chemical Engineering problems using software on the Department's PC network.
- Chemical Engineering Teaching Laboratory: this is mainly experiments in the areas of fluid mechanics and transport processes; it includes some engineering applications experiments for those who read science in the first year.
- Exercises: a set of calculational exercises which allow students to apply knowledge gained in lectures to realistic engineering problems. One extended exercise is devoted to the process and mechanical design of an item of process equipment.
- Engineering Drawing: for those who read Science in the first year.
- Physical Chemistry Laboratory: for those who read Engineering in the first year.
- Professional Skills: modules, some of which are presented by speakers from industry, to develop transferable skills in presentation, team working, project planning, management of people and manufacturing.

**Part IIA**

A student who has gained honours in Part I of the Chemical Engineering Tripos may take Chemical Engineering Part IIA. A student who has not read Chemical Engineering Part I may apply to the Chemical Engineering and Biotechnology Syndicate to be given leave to take Chemical Engineering Part IIA.

In Part IIA students are taken to a professional level in well-established areas of the discipline.

There are lecture courses on:
- Fundamentals: advanced fluid mechanics; equilibrium thermodynamics; radiative heat transfer; corrosion and materials.
- Process Operations: heterogeneous reactors; advanced separations; bioprocessing; particle processing.
• Process Systems: process dynamics and control; process synthesis; safety, health and environment.
• Mathematical Methods: statistics; partial differential equations.

In addition, students are required to undertake:
• Exercises: a set of exercises, with some practical demonstrations, which allow students to apply the knowledge gained in lectures to realistic engineering problems. At least one exercise will involve a literature survey.
• Design Project: involves the conceptual and process design of a major process plant. The Design Project is carried out in groups of five or six students, and includes all the important aspects of Chemical Engineering Design – process flowsheet development, equipment specification, control, economics, safety (including a HAZOP study), environmental considerations and reporting.

Students who have gained honours may leave the course at the end of Part IIA, qualified to graduate with the B.A.(Hons) degree; they will not have satisfied all the academic requirements for corporate membership of the Institution of Chemical Engineers.

Part IIB

A student who has attained a satisfactory standard (normally class II.2 or higher) in Part IIA of the Chemical Engineering Tripos may take Chemical Engineering Part IIB, leading to the M.Eng. degree.

The Part IIB course contains a set of optional courses as well as some compulsory material: this structure is different from that of Parts I and IIA, as befits a course at Master’s level.

The following courses are compulsory:
• Sustainability in Chemical Engineering: this covers aspects of environmental science and describes the methods used to quantify the sustainability of industrial processes.
• Energy Technology: this covers the application of chemical engineering principles to energy technology. It includes consideration of combustion processes, renewable energy, and nuclear energy.
• Chemical Product Design: this course considers how new products can be identified and developed. Students undertake projects to propose products that have specific attributes, and then comment on the process route and technology that would be needed to make them.
• Research Project: each student undertakes a major project, usually in collaboration with another student, closely supervised by a member of staff. The results of each project are presented to the Examiners by individual written report, and to the Department by oral presentation and poster.

Students choose six modules from a list that comprises both advanced chemical engineering topics and broadening material topics. At least two of the modules chosen need to be classed as Chemical Engineering (Depth). At least two of the modules chosen need to be classed as Chemical Engineering (Breadth). The available modules vary from year to year, depending on the interests and availability of the teaching staff. The options in 2017-18 are as follows:

• Chemical Engineering (depth) topics: fluid mechanics and the environment, interface engineering, pharmaceutical engineering; rheology and processing; computational fluid dynamics.
• Chemical Engineering (breadth) topics: optimisation; bionanotechnology, biophysics, biosensors, entrepreneurship; foreign language.

Programme outcomes

On completion of Part I, students should have:
• made the transition from Science or Engineering to Chemical Engineering, appreciating the chemical engineer's approach and acquiring the necessary missing background in mechanics (and engineering drawing) or chemistry (including laboratory work);
• appreciated the nature and technical purpose of many items of chemical engineering equipment;
• understood the economic purpose of, and some of the economic, safety, health and environmental constraints on, the chemical engineer's activities;
• acquired competence at applying basic understanding, and the equations and techniques that encompass that understanding, to a wide range of practical situations including biotechnology;
• acquired suitable mathematical, computational and professional skills;
• become experienced at taking experimental measurements, particularly in the areas of fluid mechanics and transport processes;
• completed a project on the design of an item of process equipment.

On completion of Part IIA, students should have:
• made the transition to the greater intellectual demands of work at this level, as appropriate to a B.A.(Hons) candidate;
• extended the range of items of equipment whose nature and purpose they appreciate;
• acquired a process systems outlook, through study of appropriate courses and by completing a major design project;
• acquired a more profound understanding of safety, health and environmental issues, including hazard analysis by quantitative techniques;
• deepened and widened their competence at applying basic understanding, with the corresponding equations and techniques, to a wider range of practical situations including biological science;
• acquired statistical and further mathematical skills;
• prepared themselves to make informed choices amongst the options offered in Part IIB;
• learned how to succeed at group working.

On completion of Part IIB, students should have:
• made the transition to the intellectual demands of work appropriate to an M.Eng. candidate;
• further familiarised themselves with the environmental context of the chemical engineer's activities;
• enhanced their intellectual breadth by studying "broadening material" modules;
• enlarged their store of chemical engineering expertise in a self-selected variety of topics;
• experienced the trials, tribulations and satisfactions of original research and thereby qualified themselves, in part, to undertake, commission or supervise such work;
• satisfied all the academic requirements for corporate membership of the Institution of Chemical Engineers, provided that they also performed satisfactorily in the design elements of the course.
Teaching and Learning Methods

Teaching is delivered by lectures and classes. Experimental, design and research skills are developed through coursework activities and project work. Analysis and problem solving skills are developed through question sheets issued by the course lecturers and through assessed exercises. Team working and presentation skills are developed during the design and research projects. The Cambridge Colleges provide additional teaching in the form of regular supervisions (small group teaching) for all students.

Assessment

The lecture courses are assessed mainly by unseen written examinations. Laboratory work, Drawing, Computing Classes and Exercises are continuously assessed. Design and Research Projects are assessed after submission of a final project report, although continuous feedback on progress is given. Two of the Part IIB breadth topics, Entrepreneurship and Foreign Language, are assessed externally.

Curriculum Development

The course continues to evolve as the Department continues to seek ways of developing it.

- The curriculum is subject to continuing review by the department's Undergraduate Teaching Committee. A flow of student comment that informs discussions is elicited by the quality management procedure described below.
- The optional courses in Part IIB are reviewed every year and reflect the evolving research interests of the staff.
- The research projects undertaken by the Part IIB class reflect the continuing advances in our research programmes.
- We have a Teaching Consortium consisting of representatives of about 10 companies involved in the process industries. The Teaching Consortium provides us with regular advice on curriculum development from an employer's point of view.
- We receive regular accreditation reviews by the Institution of Chemical Engineers, giving us a regular cue to review our curriculum.
- We are careful to learn lessons from the continuing flow of visiting academics through the department.

Quality Management

The Chemical Engineering and Biotechnology Syndicate is the Faculty Board equivalent that is responsible for all teaching in the Department. Undergraduate teaching is managed by the Director of Teaching who chairs an Undergraduate Teaching Committee. This committee considers both management and strategic issues, and reports to a University Teaching Officer Committee and to the Syndicate as appropriate. Issues of undergraduate quality assurance are handled by the Undergraduate Teaching Committee or the Syndicate as appropriate.

The quality of the course is maintained by:

(i) consideration of the reports of External Examiners by the University Teaching Officer Committee, the Chemical Engineering and Biotechnology Syndicate, and by the General Board's Education Committee;

(ii) consideration of the reports of Internal Examiners by the Undergraduate Teaching Committee and the University Teaching Officer Committee;

(iii) student feedback through teaching unit questionnaires, and end-of-course questionnaires;
(iv) student feedback by representatives on the Staff-Student Consultative Committee and the Chemical Engineering and Biotechnology Syndicate;
(v) student feedback to Directors of Studies, describing their learning experiences including College supervisions;
(vi) self-assessment by Teaching Unit Reviews, which are reviewed by the Director of Teaching and the Head of Department;
(vii) appraisal of staff;
(viii) the General Board's programme for reviewing Faculties and Departments every six years.

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. 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/