# Programme Specification

## A statement of the knowledge, understanding and skills that underpin a taught programme of study leading to an award from The University of Sheffield

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| **1** | **Programme Title** | Chemical Engineering with Energy |
| **2** | **Programme Code** | CPEU05 |
| **3.** | **JACS Code** | H800 |
| **4** | **Level of Study** | Undergraduate |
| **5a** | **Final Qualification** | Master of Engineering (MEng) |
| **5b** | **FHEQ Level** | Masters – 7 |
| **6** | **Intermediate Qualification** | BEng (Hons) Chemical Engineering<br>(see separate Programme Specification) |
| **6b** | **FHEQ Level** | Honours – 6 |
| **7** | **Teaching Institution** (if not Sheffield) | Not applicable |
| **8** | **Faculty** | Engineering |
| **9** | **Department** | Chemical and Biological Engineering |
| **10** | **Other Departments involved in teaching the programme** | School of Mathematics and Statistics<br>Automatic Control & Systems Engineering |
| **11** | **Mode of Attendance** | Full-time |
| **12** | **Duration of the Programme** | 4 years |
| **13** | **Accrediting Professional or Statutory Body** | Institution of Chemical Engineers, Energy Institute |
| **14** | **Date of production/revision** | July 2020, March 2023 |

**15. Background to the programme and subject area**

Chemical engineering is concerned with the application of science to the design, construction and operation of processes in which materials undergo changes. The applications of these changes are necessary for the production of commodities essential to our everyday life. These include food and drink, pharmaceuticals, fertilisers, man-made fibres, plastics, fuels and energy. Manufacturing activities require processes that provide the efficient and safe conversion of raw materials into useful products. This should be achieved at the lowest possible cost, with minimum energy consumption whilst ensuring safe operation and minimum impact on the environment. Chemical Engineers are involved in developing new processes, both chemical and biological for synthesising new products and optimising the performance of existing process systems. Qualified Chemical Engineers can choose from a wide variety of career opportunities including plant management, research, commissioning, process safety, environmental protection, process control, consultancy or marketing and sales.

Students choosing to study this subject at the University of Sheffield are provided with a thorough understanding of chemical engineering by combining theoretical aspects of the discipline with hands-on practical experience. The programme also provides the first part of the academic qualifications for students wanting to enter the chemical engineering profession and progress to Chartered Engineer (CEng) status. All students are encouraged to become student members of the Institution of Chemical Engineers and/or the Energy Institute. Both professional bodies have active local branches which organise seminars and visits. Through these experiences, graduates are therefore well-equipped to meet the challenge of working within an ever-changing discipline and succeed in the wide range of career areas described above.

In addition to the clearly vocational orientation of the programme, students also benefit from the Department's research activity, which informs its teaching. The Department has four internationally leading research themes: Biological Engineering, Processes and Systems, Materials & Products and Circular Economy. The specialist subjects available in the 3rd and 4th year reflect the interests of staff in these groups and in the 4th year, students have the opportunity to carry out a novel research project on their own, with guidance from a member of staff, in one of these research areas.

The Department's MEng programmes provide an increased breadth and depth of study beyond that of the BEng

in Chemical Engineering, with additional emphasis on industrial relevance. At MEng level, additional emphasis is placed on team/group working, an increase in the use of industrially relevant applications of engineering analysis, and an enhanced capability for independent learning and work.

The MEng Chemical Engineering with Energy focuses on all aspects of the energy sources, supply, processing and use of various fuels. It includes the efficient utilisation of renewable (e.g. biomass, solar) and non-renewable fuels (e.g. coal, oil and natural gas), the generation of electricity and heat from fossil, biomass or nuclear fuels and the refining of petroleum. Atmospheric pollution and climate change are strongly associated with fossil fuels. The programme covers solutions to some of the challenges by exploring more efficient and clean energy systems and improved power generation processes. Teaching of the programme is research-led and delivered by world class experts in the field.

Students should note that if they fail CPE31003 (Design Project) they would normally be recommended for the award of an Ordinary BEng degree in Chemical Engineering.

Further information about the Department can be found at http://www.shef.ac.uk/cbe.

**16. Programme aims**

The University's Mission is to provide students from a wide variety of educational and social backgrounds with high-quality education in a research-led environment using staff working at the frontiers of academic enquiry. The Department of Chemical and Biological Engineering implements this through its strong commitment to both teaching and research. It also aims to engender in its students a commitment to future self-learning and social responsibility. The department's vision is to create graduates who generate solutions for 21st century grand challenges, who are open and outward focused, comfortable working in or leading culturally diverse and interdisciplinary teams and excited to attack complex and wicked problems. The graduates will be innovative product developers and forward looking, risk taking, trailblazer. They will be proud of the manufacturing heritage of their university and city.

The aims of the MEng programmes are to:

1. Provide access to an engineering degree to students from a range of academic and social backgrounds;
2. Deliver a coherent curriculum embedded in design and practice with an emphasis on critical thinking, problem solving, professionalism, ethics and sustainability;
3. Offer flexible learning environments and pathways to facilitate deep engagement;
4. Promote and facilitate industry involvement by focusing on both process and product engineering to develop industry ready practical graduates with hands on experience;
5. Produce graduates who are integrators, change agents and self-directed learners to lead multidisciplinary teams, and be at the forefront of innovation;
6. Provide exposure to niche research areas built on a strong core in engineering fundamentals;
7. Produce graduates capable of Engineering from molecules by applying systems level thinking at many length scales;
8. Foster safe and good laboratory practice;
9. Encourage students to think for themselves and develop a social awareness of the impact of chemical engineering on society;
10. Promote the free pursuit of knowledge and develop an ability to find, understand and analyse information;
11. Meet the requirements for the associate membership level of the relevant professional bodies;
12. Provide students with an education through a firm understanding and practical knowledge in energy engineering.

**17. Programme learning outcomes**

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| In addition to the core learning outcomes in chemical engineering, students studying Chemical Engineering with Energy will have developed further knowledge and skills relevant to their chosen specialism. | |
| **Knowledge and Understanding:** | |
| Students will have a knowledge and understanding of the: | |
| **K1** | fundamental principles of engineering science relevant to chemical and biological engineering; |
| **K2** | mathematics necessary to apply engineering science to chemical and biological engineering; |
| **K3** | analytical and design methods used in chemical and biological engineering; |
| **K4** | use of information technology for analysis, design and management; |
| **K5** | operation of the chemical and biological engineering industry, including business practice and project management; |
| **K6** | professional responsibility of chemical engineers and the influence of social, environmental, ethical, economic and commercial considerations on their activities; |
| **K7** | knowledge of the principles and practice of energy engineering in the industries and energy sector. |

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| **Skills and other attributes:** | |
| **Intellectual Skills -** Students will be able to: | |
| **I1** | use engineering science, mathematics and, where appropriate, information technology to analyse engineering problems; |
| **I2** | analyse and interpret experimental and other numerical data; |
| **I3** | produce designs in a professional manner, taking account of social, environmental, ethical and commercial considerations; |
| **I4** | carry out a health and safety risk assessment and devise a safe system of working; |
| **I5** | display creativity and innovation in solving unfamiliar problems; |
| **I6** | exercise independent thought, critical thinking and judgement; |
| **I7** | perform a technical investigation; |
| **I8** | produce solutions to problems through the application of energy engineering knowledge and understanding. |

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| **Practical Skills -** Students will be able to: | |
| **P1** | use appropriate mathematical methods for modelling and analysing chemical and biological engineering problems; |
| **P2** | use relevant test and measurement equipment; |
| **P3** | design and conduct experimental laboratory work; |
| **P4** | use chemical engineering IT tools and programming; |
| **P5** | design systems, components or processes and test design ideas in the laboratory or through simulation; |
| **P6** | prepare technical reports and presentations; |
| **P7** | undertake the safe handling of chemical materials, taking into account their physical and chemical properties, including a risk assessment of any specific hazards associated with their use. |

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| **Transferable Skills -** Students will be able to: | |
| **T1** | use information technology effectively; |
| **T2** | communicate effectively, orally and in writing; |
| **T3** | lead and collaborate with others in teams; |
| **T4** | manage time, teams and projects efficiently; |

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| **T5** | find information and learn independently; |
| **T6** | develop employability skills. |

**18. Teaching, learning and assessment**

**Development of the learning outcomes is promoted through the following teaching and learning methods:**

The main teaching, learning and assessment methods adopted for each learning outcome are shown below. In most cases a combination of methods is used. Emphasis is on 'learning by doing'. Knowledge and understanding are gained through a combination of lectures, tutorials, example classes, design classes, laboratory experience, open-ended problem solving and coursework assignments. Skills are acquired mainly through coursework and individual and group projects.

**Lectures** – used to transmit information, explain theories and concepts, and illustrate methods of analysis or design. For most lecture courses tutorial sheets are provided to enable students to develop their understanding during private study.

**Practical activities** – students undertake laboratory experiments, open-ended problem solving and computing tasks to gain practical skills.

**Tutorials and example classes** – run for individuals, small groups or a whole class to help students with their understanding and to resolve problems in their programme materials.

**Research projects** – individual project contributing to novel research in chemical and biological engineering.

**Research seminars** – there is a regular schedule of departmental research seminars during the teaching session. Level 4 students are encouraged to attend.

The approach to teaching design encourages students to take a wide perspective on problems and to develop their powers of synthesis, analysis, creativity and judgement as well as clarity of thinking. Students are provided with the context and framework for the application of the scientific, technical and other knowledge which is taught elsewhere in the programme through the methods described above. The principal methods for design teaching are:

**Design classes** – students work to solve design problems related to real chemical and biological engineering situations in order to learn design methods and to practice associated analytical techniques.

**Design projects** – teams of 6-7 students tackle a chemical engineering problem by working through conceptual and detailed design stages.

In addition to planned teaching and learning activities, students are also expected to learn through the preparation of coursework assignments and other assessment activities which generally require students to seek additional information and work on their own, or in small groups, to develop further understanding of the subject matter.

**Opportunities to demonstrate achievement of the learning outcomes are provided through the following assessment methods:**

Knowledge and understanding are primarily assessed in written examinations. However, in the later years further knowledge and understanding is gained through project work and assessed in written reports and oral presentations.

**Written examinations** – unseen examinations.

**Coursework submission** – designed to test knowledge and communication skills; these include design studies, computing assignments and laboratory reports.

**Class tests and online tests** – tests conducted in a lecture theatre or on the virtual learning portal during the main teaching periods to assess progress.

**Oral presentations** – most group projects include an oral presentation in which each group member plays a part.

**Individual and group project reports** – these include intermediate and final reports for the Design Project and Research Project.

| LEARNING OUTCOME (abbreviated - see Section 17 for full text) | Teaching/Learning | | | | | | | | Assessment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Formal lectures | Formal subject tutorials | Labs – Level 1 – bench scale | Labs – Level 2 – pilot plant | Computing classes | Small group project work | Individual project work | Tutorials with personal tutor | Formal unseen examination | Laboratory reports | Project reports | Design portfolio | Group presentations | Individual presentations |
| K1 Fundamental principles | • | • | • | • | • | • | • | | • | • | • | | | |
| K2 Mathematics | • | • | • | • | • | | | | • | • | • | • | | |
| K3 Analytical / design methods | • | • | | | | • | • | | • | | | • | • | • |
| K4 Information technology | • | | | | • | | | | | | • | | | |
| K5 Industry / business | • | | | | | • | | • | • | | | | | • |
| K6 Professional responsibility | • | | | | | • | • | | • | | | • | • | • |
| K7 Energy engineering | • | • | | | | • | • | • | • | | | | • | • |
| I1 Analyse problems | | | • | • | • | • | • | | • | • | • | • | | |
| I2 Analyse / interpret data | | • | • | • | | • | • | | • | • | • | | | |
| I3 Produce designs | | | | | | • | • | | | | | • | • | • |
| I4 Carry out risk assessment | • | | | • | | • | • | | • | | | • | • | • |
| I5 Display creativity / innovation | | | | | | • | • | | | | • | • | | |
| I6 Exercise independent thought | | | | | | • | • | | | • | • | • | | • |
| I7 Technical investigation | | | | | | • | • | | | | • | • | • | • |
| I8 Energy engineering solutions | • | • | | | | • | • | • | • | | | | • | • |

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| P1 Use mathematical methods | • | • | • | • | • | • | • | | • | • | • | • | | |
| P2 Use equipment | | | • | • | | • | • | | | • | • | | | |
| P3 Conduct experiments | | | • | • | | | • | | | • | • | | | |
| P4 Use IT and software | | | | | • | | • | | | • | • | | • | • |
| P5 Design systems and test | | | | | | • | • | | | | | • | | |
| P6 Prepare technical reports | | | | | | • | • | | | | • | • | | • |
| P7 Chemical safety | | | • | • | | • | • | | • | • | • | • | • | • |
| T1 Use IT effectively | | | | • | • | • | | | | • | • | | • | • |
| T2 Communicate effectively | | | | | | • | | • | | | | | • | • |
| T3 Collaborate in teams | | | | | | • | | • | | | | | • | |
| T4 Manage time efficiently | | | | | | • | • | | | | | • | • | |
| T5 Learn independently | | | | | | | • | • | | | | • | | • |
| T6 Employability skills | | • | | • | | • | • | | | | | | | • |

**19. Reference points**

**The learning outcomes have been developed to reflect the following points of reference:**

Subject Benchmark Statements
https://www.qaa.ac.uk/quality-code/subject-benchmark-statements

Framework for Higher Education Qualifications (2014)
https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf

University Strategic Plan
https://www.sheffield.ac.uk/vision

'Accreditation of Chemical Engineering Programmes based on Learning Outcomes", Institution of Chemical Engineers, September 2015.

'Academic Standards – Engineering', Subject Benchmark Statement, Quality Assurance Agency for Higher Education, 2015.

In assessing students' achievement of the learning outcomes, the level of performance, e.g. the extent of knowledge and depth of understanding, will be compliant with guidance given in the above references.

## 20. Programme structure and regulations

**MEng Chemical Engineering with Energy**
The programme structure is modular and in each year students study modules worth a total of 120 credits. The first two years (Levels 1 and 2) are taught through a series of compulsory 10-20 credit modules, and are shared across all undergraduate programmes, in order to accommodate transfers between these programmes (see below).

At Levels 1 & 2, students also participate in a cross-faculty week-long group project: “Global Engineering Challenge” in Year 1 and “Engineering: You’re Hired” in Year 2. These are an opportunity for students across the Faculty of Engineering to work together in multi-disciplinary teams, enabling them to develop a range of professional and technical competences, including awareness of the global context of their decisions, communication skills, cultural agility and enterprising problem solving. Neither of these group projects are credit bearing, but both are compulsory for progression to year 3. In addition, all students take a core ‘CBE Skills for Employability’ module, which has been developed as a programme level non-credit bearing module, designed to help students in planning their career development, and to equip them with the essential knowledge, know-how and practical skills needed to succeed in the recruitment process and be competitive in the job market.

Levels 3 and 4 of the curriculum for the MEng in Chemical Engineering with Energy are programme-specific. At Level 3, the core curriculum includes a series of compulsory modules to the value of 75 credits plus a 45-credit design project, which involves working in a small supervised group on the process design of a chemical plant. At Level 4, the major feature is a 45-credit individual research project. Some of the projects are linked to industry. Students also undertake further compulsory 15-credit modules totalling 45 credits with the remaining 30 credits available for studying optional modules.

To enable graduates to become Chartered Engineers (CEng), the Engineering Applications component specified by the Engineering Council (the application of scientific and engineering principles to the solution of practical problems of engineering systems and processes) is embedded throughout the programme. It is initially introduced during Levels 1 and 2 and includes dedicated design weeks and a week of practical activities along with visits to local chemical engineering industry. It is then continued through the Level 3 design project and requires both group and individual work.

**Changing programmes of study**
As students become more familiar with the material covered within the programme their special interests may change. The programmes have therefore been designed to be flexible to allow for transfer between the various programmes. All undergraduate programmes follow exactly the same modules during Levels 1 and 2. At the end of Level 2, students also have the option of changing to the BEng in Chemical Engineering (*see separate Programme Specification*), and so complete a degree in one further year. Also at this time, students who have not attained the necessary academic standard during the first two years, currently set at an overall average of 54.5% in the second year examinations, will normally be required to transfer to the BEng programme.

Information concerning individual modules can be found online at www.shef.ac.uk/cbe.

Detailed information about the structure of programmes, regulations concerning assessment and progression and descriptions of individual modules are published in the University Calendar available on-line at http://www.sheffield.ac.uk/calendar.

## 21. Student development over the course of study

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| **Level 1**<br><br>(1st year) | The first year of the programme aims to consolidate students’ existing scientific knowledge of mathematics and science and also provide some relevant knowledge of other sciences to fill any gaps, while at the same time introducing the basic principles of chemical engineering. Students will undertake practical experiments and will be able to present, interpret and evaluate data reliably. They will develop communication skills and teamwork through participation in design and tutorial exercises which will require them to have developed lines of argument and make sound judgements in accordance with basic theories and concepts of chemical engineering. |

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| **Level 2**<br><br>(2nd year) | Over the following year, students will develop a more extensive knowledge and deeper understanding of the principal chemical engineering subjects, with an emphasis on real applications. Students will also extend their knowledge of computing and background information on other relevant engineering applications. They will further develop their practical skills and solve more difficult chemical engineering problems. Students will undertake more detailed design work in which some elements of professional practice are introduced. |
| **Level 3**<br><br>(3rd year) | At Level 3, the programme is aimed at broadening knowledge of the chemical process industries by introducing further topics together with more advanced treatment of the subjects covered during Level 2. Students will carry out a complex realistic design project which will require the application of knowledge and understanding gained in earlier years, both of technical subjects and of professional issues. Students will work in self-directed groups, enhancing communication and team-working skills. |
| **Level 4**<br><br>(4th year) | Students will study current issues at the forefront of chemical engineering. Their knowledge and understanding of professional issues and management will be enhanced. They will carry out an energy focused individual research project and demonstrate an ability to carry out independent research and critically evaluate the results. They will display levels of creativity, originality and judgement comparable with those expected of Masters' degree graduates and upon successful completion of the programme, will have developed and demonstrated achievement of the overall programme outcomes outlined in Section 17. |

**22. Criteria for admission to the programme**

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| Detailed information regarding admission to the programme is available at http://www.sheffield.ac.uk/study/. |

**23. Additional information**

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| Further information is available in the departmental brochure "Undergraduate Courses" available from the Department of Chemical and Biological Engineering or online at http://www.shef.ac.uk/cbe/ug/courses. |
| This specification represents a concise statement about the main features of the programme and should be considered alongside other sources of information provided by the teaching department(s) and the University. In addition to programme specific information, further information about studying at The University of Sheffield can be accessed via our Student Services web site at http://www.shef.ac.uk/ssid. |