Subject Benchmark Statement

Engineering

October 2019
# Contents

How can I use this document? ........................................................................................................... 1

About the Statement ........................................................................................................................... 2

Relationship to legislation ................................................................................................................ 2

Summary of changes from the previous Subject Benchmark Statement (2015) ......................... 2

1  Introduction.................................................................................................................................. 3

2  Nature and extent of the subject .................................................................................................. 4

3  The characteristics of engineering graduates ............................................................................. 5

4  Engineering degrees as preparation for professional practice .................................................. 6

5  Professional accreditation of academic courses ........................................................................ 7

6  Engineering at bachelor’s degree with honours and master’s degree levels .......................... 8

7  Teaching, learning and assessment .............................................................................................. 9

8  The standards................................................................................................................................. 11

Appendix: Membership of the benchmarking and review groups for the Subject Benchmark Statement for Engineering .................................................................................................................. 12
How can I use this document?

This is the Subject Benchmark Statement for Engineering. It defines the academic standards that can be expected of a graduate, in terms of what they might know, do and understand at the end of their studies, and describes the nature of the subject.

The UK Quality Code for Higher Education (Quality Code) sets out the Expectations and Core practices that all providers of UK higher education are required to meet. Providers in Scotland, Wales and Northern Ireland must also meet the Common practices in the Quality Code.

The Quality Assurance Agency for Higher Education (QAA) has also published a set of Advice and Guidance, divided into 12 themes, and a number of other resources that support the mandatory part of the Quality Code. Subject Benchmark Statements sit alongside these resources to help providers develop courses and refine curricula but are not part of the regulated requirements for higher education providers in the UK.

This Statement is intended to support you if you are:

- involved in the design, delivery and review of courses of study in engineering or related subjects
- a prospective student thinking about studying this subject, or a current student of the subject, to find out what may be involved
- an employer, to find out about the knowledge and skills generally expected of a graduate in this subject.

Subject Benchmark Statements provide general guidance for articulating the learning outcomes associated with the course but are not intended to represent a national curriculum in a subject or to prescribe set approaches to teaching, learning or assessment. Instead, they allow for flexibility and innovation in course design within a framework agreed by the subject community.

It may be helpful to refer to relevant Advice and Guidance when using this Statement.

Explanations of unfamiliar terms used in this Subject Benchmark Statement can be found in QAA's Glossary.
About the Statement

This Subject Benchmark Statement refers to bachelor's degrees with honours and master's degrees in engineering.¹

It has been produced by a group of subject specialists drawn from, and acting on behalf of, the subject community. The process is facilitated by QAA, as is the full consultation with the wider academic community and stakeholder groups each Statement goes through.

In order to ensure the continuing currency of Subject Benchmark Statements, QAA initiates regular reviews of their content, five years after first publication, and every seven years subsequently, or in response to significant changes in the discipline.

The Statement is aligned to, and should be read in conjunction with, the Engineering Council publication Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence.²

Relationship to legislation

Higher education providers are responsible for meeting the requirements of legislation and any other regulatory requirements placed upon them, for example by funding bodies. This Statement does not interpret legislation, nor does it incorporate statutory or regulatory requirements. The responsibility for academic standards remains with the higher education provider who awards the degree.

Higher education providers may need to consider other reference points in addition to this Statement in designing, delivering and reviewing courses. These may include requirements set out by professional, statutory and regulatory bodies (PSRBs), and industry or employer expectations.

Sources of information about other requirements and examples of guidance and good practice are signposted within the Subject Benchmark Statement where appropriate. Individual higher education providers will decide how they use this information.

Summary of changes from the previous Subject Benchmark Statement (2015)

This version of the Statement forms its fourth edition, following initial publication of the Subject Benchmark Statement in 2000 and review and revision in 2006 and 2015.

This latest version of the Statement is the consequence of the revision to the UK Quality Code for Higher Education which was published in 2018. It has been revised to update references to the Quality Code and other minor changes within the sector. Changes have been made by QAA and confirmed by a member of the most recent review group.

There have been no revisions to the subject-specific content of the statement.

¹ Bachelor's degrees are at level 6 (Master's at level 7) in The Framework for Higher Education Qualifications in England, Wales and Northern Ireland and level 10 (Master's at level 11) in The Framework for Qualifications of Higher Education Institutions in Scotland, as published in The Frameworks for Higher Education Qualifications of UK Degree-Awarding Bodies.

² Available at: www.englc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep
1 Introduction

1.1 The purpose of this Statement is to describe the academic standards expected of graduates of bachelor's degrees with honours and master's degrees in engineering. It also describes the attributes and capabilities that engineering graduates will have, and the nature of teaching, learning and assessment in engineering.

1.2 This Statement is to be read in conjunction with the Engineering Council's Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence - derived from the UK Standard for Professional Engineering Competence - which sets out the output standards required of engineering courses accredited for the purposes of registration as a professional engineer (see Section 4).

1.3 Since 2006, the engineering community has agreed that the academic standards expected of engineering graduates are the same as the learning outcomes for graduates of Engineering Council accredited degrees, as set out in the Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence. For this reason a separate list of standards is not provided in this Subject Benchmark Statement. Instead, readers are referred to the Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence. Additional information is provided about how the Accreditation of Higher Education Programmes output standards can be interpreted in the context of academic standards.

1.4 The advantages of this approach include enabling higher education providers to work from a single point of reference to meet academic and professional standards, and minimising the danger of conflicting interpretations, either in higher education providers or accrediting agencies.

1.5 It is acknowledged that, while most engineering degree courses in the UK are accredited, and completing an accredited degree makes the subsequent process of registration as a professional engineer more straightforward, such accreditation is not a requirement for the academic purposes of this Subject Benchmark Statement. This Subject Benchmark Statement applies equally to accredited and unaccredited courses. Graduates of all engineering degree courses are expected to achieve the academic standards described.

1.6 Course providers use this Statement to establish standards for a diverse range of courses, hence encouraging innovation and creativity in curriculum design. It is important to note that the use of the Subject Benchmark Statement on its own in course design is not sufficient to secure professional accreditation for the course.

1.7 For joint or interdisciplinary courses it may be appropriate to draw on a number of Subject Benchmark Statements. This document is still an essential reference point for the engineering component of the course.

1.8 Given the general understanding that technology is the product of engineering, reference in this document to engineering and engineering degrees should be taken to include technology.
2 Nature and extent of the subject

2.1 Engineering drives technological, economic and social progress. It deals with the delivery of practical solutions to problems, which includes addressing some of the greatest challenges and opportunities of our rapidly evolving world. Engineers apply their understanding, knowledge, experience, skills and know-how to create social and economic value.

2.2 Engineering is concerned with developing, providing and maintaining infrastructure, products, processes and services for society. Engineering addresses the complete life cycle of a product, process or service, from conception, through design and manufacture, to decommissioning, recycling and disposal, within the constraints imposed by economic, legal, social, cultural and environmental considerations.

2.3 Engineering relies on three core elements, namely scientific principles, mathematics, and realisation. Scientific principles underpin all engineering, while mathematics is the language used to communicate parameters and to model and optimise solutions. Realisation encapsulates the whole range of creative abilities which distinguish the engineer from the scientist: to conceive, make and actually bring to fruition something which has never existed before - and to create intellectual property, associating invention with commercial or social value. This creativity and innovation to develop economically viable and ethically sound sustainable solutions is an essential and distinguishing characteristic of engineering, shared across the many diverse, established and emerging subjects within the discipline.

2.4 Engineers based in the UK or working for UK-registered businesses are engaged in projects all over the world, and many will spend time working overseas in other offices, in production units or on construction sites. Engineering underpins most exported goods and many services. This is one of the attractions for many people to a career in engineering. Higher education is equally a global activity. UK universities have long attracted international students, in engineering as in all other subjects. UK students are also attracted to undertake all or part of their studies overseas. There is therefore an increasing interest in the learning outcomes of different countries’ engineering courses.

2.5 The UK is a member of international accords, comprising engineering degree accreditation bodies in a number of countries, who agree to recognise each other’s accreditation decisions. Accredited UK courses are also aligned to the international EUR-ACE® framework. Such accords and frameworks make it possible to compare international courses (to identify what is often referred to as 'substantial equivalence') for registration purposes, and encourage mobility and diversity across the student body and the profession as a whole. They are of growing importance with employers as a means by which to assure the skills and professionalism of engineering graduates from UK courses.

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3 See, for example, the Washington Accord for degree courses leading eventually to registration as a Chartered Engineer [www.washingtonaccord.org/washington-accord](http://www.washingtonaccord.org/washington-accord), the Sydney Accord for Incorporated Engineers [www.washingtonaccord.org/sydney](http://www.washingtonaccord.org/sydney), and the Dublin Accord for Engineering Technicians [www.washingtonaccord.org/dublin](http://www.washingtonaccord.org/dublin).

3 The characteristics of engineering graduates

3.1 The creative way of approaching all engineering challenges is being seen increasingly as a 'way of thinking' which is generic across all engineering disciplines. In order to operate effectively, engineering graduates thus need to possess the following characteristics. They will:

- be pragmatic, taking a systematic approach and the logical and practical steps necessary for often complex concepts to become reality
- seek to achieve sustainable solutions to problems and have strategies for being creative, innovative and overcoming difficulties by employing their skills, knowledge and understanding in a flexible manner
- be skilled at solving problems by applying their numerical, computational, analytical and technical skills, using appropriate tools
- be risk, cost and value-conscious, and aware of their ethical, social, cultural, environmental, health and safety, and wider professional responsibilities
- be familiar with the nature of business and enterprise in the creation of economic and social value
- appreciate the global dimensions of engineering, commerce and communication
- be able to formulate and operate within appropriate codes of conduct, when faced with an ethical issue
- be professional in their outlook, be capable of team working, be effective communicators, and be able to exercise responsibility and sound management approaches.
4 Engineering degrees as preparation for professional practice

4.1 There are many different types of engineering degree course, but all are designed to equip their graduates with knowledge, understanding and skills which will enable them to begin a professional career in some aspect of engineering. The possession of an engineering degree is seen by many employers as an essential indication that these attributes have been achieved. Successful graduates from engineering courses are highly sought after.

4.2 Accredited engineering degrees provide the foundations for eventual professional registration. Professional recognition as an Incorporated Engineer or Chartered Engineer is achieved through membership of a professional engineering institution and registration with the Engineering Council. The formation process for an engineering professional continues after graduation through a mixture of work-related education, training and professional development and on-the-job experience, enabling the demonstration of competence and commitment to society, the profession and the environment. Once registered, all professional engineers have an obligation to maintain and enhance their competence.

4.3 Professional engineering occupations have many different characteristics, and much engineering activity is undertaken by teams of engineers. The breadth of roles available is reflected to some extent in the differences between the work of Incorporated Engineers and Chartered Engineers. Incorporated Engineers maintain and manage applications of current and developing technology, and may undertake engineering design, development, manufacture, construction and operation. Chartered Engineers develop solutions to engineering problems using new or existing technologies, through creativity, change and innovation. Chartered Engineers may have technical accountability for complex systems with significant levels of risk.

4.4 Not all graduates will proceed with a professional career in engineering, and the attributes of engineering graduates also make them attractive to many different sorts of employer - in industry, finance, consultancy and the public services - and as entrepreneurs in their own right.
5 Professional accreditation of academic courses

5.1 An Engineering Council accredited bachelor's degree with honours is regarded as one of the exemplifying qualifications for professional registration as an Incorporated Engineer, and may be accredited as partially meeting the educational base requirements for registration as a Chartered Engineer. Qualifications that exemplify the required knowledge and understanding for professional registration as a Chartered Engineer include an Engineering Council accredited integrated master's (MEng) or an accredited bachelor's degree with honours in engineering plus an appropriate master's degree or EngD accredited by a licensed professional engineering institution.\(^5\)

5.2 The majority of engineering degree courses are designed with a view to being accredited by a professional engineering institution on behalf of the Engineering Council. This is how the engineering profession confirms that a course of study provides the knowledge, understanding and skills necessary to underpin eventual professional competence. The focus of accreditation is primarily on the outcomes achieved, which allows for innovation in course design within the outcomes framework. Factors which have a bearing on these, such as approaches to teaching and learning, assessment strategies, human and material resources, and quality assurance arrangements, are all considered as part of the accreditation process. Accreditation may typically be granted to a course for a period of up to five years, after which re-accreditation is required.\(^6\)

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\(^5\) For further information see: www.engc.org.uk/engcdocuments/internet/Website/Flowchart%20showing%20standard%20routes%20to%20registration.pdf.

\(^6\) For further information, see the Engineering Council Website: www.engc.org.uk.
6 Engineering at bachelor's degree with honours and master's degree levels

These descriptions are based on the preambles provided in Annex A of the Accreditation of Higher Education Courses: UK Standard for Professional Engineering Competence.

Bachelor's degree with honours level

6.1 A bachelor's degree with honours in engineering may be accredited as fully meeting the education requirements for professional registration as an Incorporated Engineer (IEng), or as partially meeting the requirement for professional registration as a Chartered Engineer (CEng). For this reason, most bachelor's degrees with honours in engineering will fall into one of the two following categories. Unaccredited degrees may align with either of the below.

- Bachelor's degree with honours courses in engineering accredited for IEng have an emphasis on the development and attainment of the know-how necessary to apply technology to engineering problems and processes, and to maintain and manage current technology, sometimes within a multidisciplinary engineering environment.
- Bachelor's degree with honours courses in engineering accredited as partially meeting the requirements for CEng develop the ability to apply a thorough understanding of relevant science and mathematics to the analysis and design of technical solutions.

Master's level

6.2 MEng degrees include the outcomes of accredited bachelor's degrees with honours and go beyond them to provide a greater range and depth of specialist knowledge, often within a research and industrial environment, as well as a broader and more general academic base. Such courses provide both a foundation for leadership, and a wider appreciation of the economic, legal, social, ethical and environmental context of engineering.

6.3 The MEng course of study is designed as an integrated whole from entry to completion, although some of the earlier parts may be delivered in common with a parallel bachelor's degree with honours. MEng degrees meet the expectations of the qualifications descriptor for master's degrees in The Frameworks for Higher Education Qualifications of UK Degree-Awarding Bodies, with the additional period of study at the lower level meeting the expectations of the bachelor's degree with honours descriptors. This generally includes study equivalent to at least four full-time academic years (five in Scotland), of which study equivalent to at least one full-time academic year is at the higher level. Progression to MEng courses is subject to performance criteria that indicate likely progression to the more demanding outcomes expected for the award of a master's degree. Transfer between courses leading to bachelor's degrees with honours and MEng courses is usually possible within a higher education provider. MEng degrees are compatible with the completion of the second cycle within the overarching Qualifications Frameworks in the European Higher Education Area (QF-EHEA).

6.4 Master's degrees in engineering other than the MEng (typically MSc degrees) vary in nature and purpose. Some offer the chance to study in greater depth particular aspects or applications of a broader discipline in which the graduate holds a bachelor's degree with honours. Others bring together different engineering disciplines or sub-disciplines in the study of a particular topic, or engineering application, while a further category is truly multidisciplinary. Master's courses also provide an opportunity to integrate the technical and non-technical aspects of engineering and to develop a commitment to professional and social responsibility and ethical codes.
7 Teaching, learning and assessment

7.1 There is a holistic approach to the design of the curriculum. The methods of teaching, learning and assessment are constructed so that the learning activities and assessment tasks are aligned with the learning outcomes that are intended in the course.

Teaching and learning

7.2 Existing engineering courses have been developed over many years and deploy a diverse range of learning, teaching and assessment methods to enhance and reinforce the student learning experience. This diversity of practice is a strength of the subject. Whichever methods are employed, strategies for teaching, learning and assessment deliver opportunities for the achievement of the learning outcomes, demonstrate the attainment of learning outcomes, and recognise the range of student backgrounds. The methods of delivery and the design of the curriculum are updated on a regular basis in response to generic and subject-specific developments, taking into account educational research, changes in national policy, industrial practice and the needs of employers.

7.3 Curriculum design is informed by relevant examples of current developments, reflecting appropriate research, scholarship and industrial practice, and an understanding of the potential destination of graduates. For students to achieve a satisfactory understanding of engineering, the expectation is that they have significant exposure to hands-on laboratory work and substantial individual and group project work. The curriculum includes both design and research-led projects, which develop in graduates both independence of thought and the ability to work effectively in a team. Teaching and learning needs to be placed within the context of social, ethical, legal, environmental and economic factors relevant to engineering.

7.4 Teaching and learning methods within an MEng course build upon a bachelor's degree with honours through the deepening of technical understanding, additional emphasis 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. Case studies, design work and projects are generally utilised more extensively, especially towards the end of the course when they build upon earlier learning. The inclusion of such elements within the design of MEng courses prepares students for subsequent leading roles in technical and/or managerial activities. Periods of work in industry may also be used to supplement the formal study. Where this is the case, courses may be of extended duration to ensure that all of the academic requirements and components have been covered.

7.5 Teaching and learning for other master's degrees (typically MSc degrees) depends to a large extent on the focus of the course, but may include increased specialisation, breadth or depth of subject material.

7.6 There is an expectation that master's students will be increasingly self-reliant, particularly during the later stages of their course.

7.7 Teaching and learning resources specific to engineering, and other help and advice, are available from the Higher Education Academy.

Assessment

7.8 An implication of defining output standards for engineering degrees is that all students graduating with such degrees are able to demonstrate that they have achieved these standards. Course providers need to make clear how this is ensured.
7.9 Assessment is the means by which students are measured against benchmark criteria and also forms a constructive part of the learning process. There is a course-level approach to assessment that ensures output standards are met. Further information and guidance on assessment and feedback is available from the Higher Education Academy.
8 The standards

8.1 Readers are referred to the Engineering Council's Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence for full details of the academic standards for bachelor's degrees with honours and master's degrees in Engineering.

8.2 For the purposes of this Subject Benchmark Statement, the output standards set out in the Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence should be interpreted as threshold academic standards. It is anticipated that most students will exceed the threshold level.

8.3 The Accreditation of Higher Education Programmes: UK Standard for Professional Engineering Competence includes two sets of output standards for bachelor's degrees with honours - one for courses accredited for IEng registration, and another for courses accredited for CEng registration. Where courses are unaccredited, they should be aligned to either the IEng or the CEng pathway.
Appendix: Membership of the benchmarking and review groups for the Subject Benchmark Statement for Engineering

Membership of the review group for the Subject Benchmark Statement for Engineering (2019)

The fourth edition, published in 2019, was revised by QAA to align the content with the revised UK Quality Code for Higher Education, published in 2018. Proposed revisions were checked and verified by the Chair of the Subject Benchmark Statement for Engineering review group from 2015.

Professor Kel Fidler (Chair)  Fellow of the Royal Academy of Engineering, formerly Vice-Chancellor and Chief Executive of Northumbria University and Chairman of the Engineering Council
Dr Alison Felce  Quality and Standards Specialist, QAA

Membership of the review group for the Subject Benchmark Statement for Engineering (2015)

Details provided below are as published in the third edition of the Subject Benchmark Statement.

Dr Rob Best  London South Bank University and Accreditation of Higher Education Courses steering group
Professor David Cleland  Queen's University, Belfast
Dr Gill Cooke  Higher Education Academy and Coventry University
Professor Kel Fidler (Chair)  Fellow of the Royal Academy of Engineering, formerly Vice-Chancellor and Chief Executive of Northumbria University and Chairman of the Engineering Council
Dr Alistair Greig  University College London
Dr Daphne O'Doherty  Cardiff University
Professor Alistair Sambell  Edinburgh Napier University

QAA Officer
Dr Catherine Kerfoot  Quality Assurance Agency for Higher Education

Professional, statutory and regulatory body representative
Deborah Seddon  Engineering Council

Employer representatives
Nicola Price  Rolls Royce
Dr Mike Cook  Buro Happold Ltd and Royal Academy of Engineering

Student reader
Joshua Mullins  University of Exeter
Membership of the review group for the Subject Benchmark Statement for Engineering (2006)

Details provided below are as published in the second edition of the Subject Benchmark Statement.

Professor Helen Atkinson  University of Leicester  
Janet Berkman  EEF  
Professor David Bonner (Chair)  University of Hertfordshire  
Dr Sarah Carpenter  Higher Education Academy Engineering Subject Centre  
Professor Graham Davies  University of Birmingham  
Professor John Dickens  Higher Education Academy Engineering Subject Centre  
Günter Heitmann  Technical University Berlin  
Professor Fred Maillardet  Engineering Professors' Council  
Professor Alistair Sambell  University of Northumbria  
Mr Richard Shearman  Engineering Council UK  
Mr David Young (deceased)  Universities UK  
Professor Ian Freeston (observer)  Engineering Council UK  

Membership of the original benchmarking group for engineering (2000)

Details provided below are as published in the original Subject Benchmark Statement.

Dr R Best  South Bank University  
Professor D Bonner  University of Hertfordshire  
Mr R Chinn  WS Atkins Consultants Ltd  
Dr W Cousins  University of Ulster  
Dr T Davies  University of the West of England, Bristol  
Professor K Fidler  The University of York  
Professor E Fisher  University of Newcastle upon Tyne  
Professor J Flower*  University of Warwick  
Professor D Green  University of Glasgow  
Mr D Heffer  Southampton Institute  
Dr D Morrey  Oxford Brookes University  
Dr D Pollard (Chair)  University of Surrey  
Dr R Prager  University of Cambridge  
Professor A Purvis  University of Durham  
Professor N Syred  University of Wales, Cardiff  
Professor G Taylor  Leeds Metropolitan University  
Professor C Thomas  University of Birmingham  

* (resigned due to ill health)