The University Of Sheffield.

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

1.	**Programme Title**	Materials Science and Engineering
2.	**Programme Code**	MATU46
3.	**JACS Code**	J500
4.	**Level of Study**	Undergraduate
5a.	**Final Qualification**	Master of Engineering (MEng)
5b.	**QAA FHEQ Level**	Masters
6.	**Intermediate Qualification(s)**	BEng Materials Science and Engineering
7.	**Teaching Institution** (if not Sheffield)	Not applicable
8.	**Faculty**	Engineering
9.	**Department**	Materials Science and Engineering
10.	**Other Department(s) involved in teaching the programme**	School of Mathematics and Statistics, Management School, School of Law
11.	**Mode(s) of Attendance**	Full-time
12.	**Duration of the Programme**	4 years
13.	**Accrediting Professional or Statutory Body**	The Engineering Council through the Institute of Materials, Minerals and Mining.
14.	**Date of production/revision**	September 2023

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

Materials science and engineering involves the in-depth study of the production, processing, properties and applications of man-made materials. This study is underpinned by two central themes**:**

i. the link between structure (from the atomic scale through nano and micro to the macro scale) and the chemical, physical and mechanical properties of materials; and,

ii. how control of structure through processing can be used to optimise engineering performance.

Graduates in materials science and engineering typically work at the interface between pure science and engineering. They are involved in the development of new materials, or new technologies for making or enhancing the properties of existing materials. To do this they must determine appropriate design criteria for a particular application and consider how materials with the required properties can be synthesised.

The strong research base and significant industrial links of the Department of Materials Science and Engineering at Sheffield means that both the engineering and pure science aspects of the discipline are strongly represented in our programmes. The modules comprising these programmes give students an in-depth understanding of these themes for many different materials, with an emphasis on how they are developed in the context of structural and functional applications in both industry and research. Specialisation is possible, in a context that allows comparison of competitor materials and an understanding of artefacts that combine different materials.

In the 3rd and 4th year MEng students can follow either an industrial stream or a research focussed stream. Key features of the industrial stream are i) two industrial training programmes (ITP) across years 3 and 4 involving short term industrially linked projects and ii) the industrial placement which runs from May of year 3 until September just prior to the start of year 4. These strong industrial links reinforce the subjects taught while developing key transferable skills for the workplace. Key features of the research stream are i) courses in scientific writing and outreach; ii) a heavily guided mini project in year 3 (30 credits) specifically designed to incorporate a range of essential techniques for academic and industrial research and development and iii) an elongated final year project in year 4 (80 credits) embedded within one of the outstanding research groups within materials.

Our programmes provide an effective, widely accepted route into a management role in industry or research. Our graduates have gone on to successful careers throughout the UK and the international community in materials-producing and materials-using industries, as well as in academia or research institutes.

16. Programme aims

The aims of this programmes are to:

1. enable students to develop a sound knowledge and understanding of materials science and engineering and its associated specialisms, informed by the research interests of the staff;

2. develop in students an independence of thought and a critical approach to evidence, theories and concepts, particularly in the context of materials science and engineering;

3. develop in students an appreciation of the competitive aspects of materials and their selection;

4. provide an educational base satisfying the academic requirements of the Engineering Council for a Chartered Engineer working in either the materials producer or user industries;

5. provide the educational base for a professional career in either research or a managerial role in a manufacturing industry or in a research-based institution;

6. develop in students a variety of generic skills appropriate to a wide range of graduate level employment.

17. Programme learning outcomes

Knowledge and understanding: On successful completion of the programmes, students will have knowledge and understanding of the:	
K1	science and engineering of materials from the perspective of both materials producer and user industries.
K2	thermodynamic and kinetic factors that control a material's microstructure, including phase equilibria, diffusion and reaction kinetics.
K3	structure of materials from the atomic to the macro scale, and how these structures affect properties.
K4	factors that affect the key properties of structural or functional components and how these components are used in real applications.
K5	techniques of structural characterisation, including their possible applications, the interpretation of results and potential sources of error.
K6	technologies used during the production and processing of a range of materials and their surfaces.
K7	mathematics necessary to describe the underlying scientific principles of materials production and behaviour in use, and which forms the basis of modelling.
K8	materials selection and the relative merits of different materials.
In addition to the above, on successful completion of the industrial stream, students will have detailed knowledge and understanding of:	
K9(a)	role of a professional materials engineer, and the responsibilities and challenges of materials industries and research.
In addition to the above, on successful completion of the research stream, students will have detailed knowledge and understanding of:	
K9(b)	role of a professional materials engineer, and the responsibilities and challenges of a researcher in materials related industries and academia.

Skills and other attributes

Intellectual skills: On successful completion of the programmes, students will be able to:	
I1	acquire, critically evaluate and use information relating to the properties, processing and use of materials, gathered from a range of sources and presented in various formats.
I2	identify and solve problems within the context of science and engineering.
I3	design and execute experiments in materials processing, property measurement and structural characterisation using a wide range of measuring equipment.
I4	analyse and interpret experimental and other numerical data with an awareness of sources of error and statistical accuracy.
I5	design and organise a substantial piece of individual research.
I6	function professionally and ethically in dealing with engineering problems.

Practical skills: On successful completion of the programmes, students will be able to:	
P1	conduct practical experiments.
P2	convey effectively essential aspects of materials science and engineering and its associated disciplines via high quality oral, written, numerical, graphical and visual presentations.
P3	produce some materials on a laboratory scale (particularly the appropriate class of materials for students undertaking one of the specialist programmes in ceramics, glasses, metals or polymers).
P4	use specific research equipment effectively as part of a substantial item of individual research.

Transferable skills: On successful completion of the programmes, students will be able to:	
T1	use information technology for data collection, analysis and the preparation of documents and presentations.
T2	develop and present written, numerical, graphical and visual information effectively.
T3	work individually, collaboratively and in a team.
T4	manage projects, people, resources and time.
T5	find information and learn independently.

18. Teaching, learning and assessment

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

The following are the main teaching and learning methods used**:**

Lectures – the principal formal means of imparting knowledge. Most lecturers provide lecture notes with suggested further reading. Many hand out problem sheets with worked examples to enable students to develop their understanding of the subject matter by independent study. Some sheets are marked and returned to the student; in other cases feedback is provided through discussion in subsequent lectures.

Practical classes – structured laboratory sessions enable students to develop their understanding of experimental design, methods and data interpretation. They provide good opportunities for developing team-working and communication skills, as well as skills in working individually.

Coursework assignments – provide students with opportunities to develop and demonstrate their understanding of the academic content of a module, and their skills in obtaining, using, analysing, interpreting and presenting information. They involve both individual and small group work.

Tutorials/examples classes – may be small group or up to class sized sessions, and are usually led by an academic staff member, who follows a structured programme of exercises. The classes provide students with the opportunity to resolve problems in their understanding of a module's subject matter to practise the application of theoretical concepts, and to integrate the subject matter from different courses.

Group projects - Industrial Training Programmes – undertaken in years 3 and 4 on the *industrial stream*, by groups of four to six students. These industrially linked group projects require students to utilise their academic knowledge and understanding of materials, and their communication, teamwork, project management and problem-solving skills, to tackle a small current industrial problem.

Industrial placement – this placement in year 3 of the *industrial stream* provides students with experience of working in a graduate level job in industry. It ideally enables them to apply their academic knowledge in an industrial setting, and to utilise and develop their communication, management, problem-solving and independent learning skills.

Mini research project – In year 3 of the *research stream*, there is a set of guided mini-projects whose focus is to further develop the experimental techniques of the student. These will differ from a conventional project in that the aim is to give the student prolonged and direct hands-on experience of a wide number of techniques typically used in materials research and development, e.g scanning electron microscopy, X-ray diffraction and thermal analysis. In addition, the student will receive direct guidance on scientific report writing from their supervisor and through specialised modules.

Individual research project – undertaken in year 4 under the supervision of an academic staff member (or members). This provides training for research and is an excellent opportunity for students to pull together every aspect of their development during the programme. Specifically, students on the *research stream* will be regarded as a full member of a research team and will be given research duties and responsibilities in accordance with this

status. The *research stream* project is 80 credits and the anticipated standard of research is such that the student will aim to publish their research in a major scientific journal (this is not a summative metric but a goal).

Group Engineering Projects - *The Global Engineering Challenge* - a week-long project for first year students to tackle real-world problems from a global perspective. They will be challenged to think about not only technical issues in engineering developments but also the social, ethical and environmental implications of their decisions. *Engineering -You're Hired!* - a second year project which concentrates on obtaining the skills, and evidence of those skills, that will make students highly employable as engineers.

Independent study (not included in the table on page 5) – vital for the successful completion of these programmes. Students are expected to develop this essential skill from year 1.

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

Written examinations – typically of 2 or 3 hours duration.

Coursework submissions, laboratory reports, oral presentations – these are used to assess a variety of practical and transferable skills as well as the understanding of a module.

Class tests – these are short tests conducted during the main teaching periods to assess on-going progress and understanding.

Group project Industrial Training Programmes **– undertaken in years 3 and 4** *on the industrial stream* **–** are assessed by a written group report and presentations to the companies involved.

Mini-project reports: undertaken in year 3 of the *research stream* and will constitute a sequence of guided experiments using equipment principally available with the Materials Teaching Laboratories within Diamond. Each project must contain key elements of research and development typically utilised in industry and academia and will follow the principal of 'Make, Measure, Model'. Guided report writing is an essential aspect of the mini-project and the student will be taught key writing, organisational and IT skills commensurate with a professional researcher in academia or industry.

Placement report – the placement is assessed by a written report and oral presentation to academic staff and representatives of the company during meetings in the place of work. Where student placements take place abroad the submission of regular electronic diaries is expected as an alternative to formal meetings. Reports and presentations are expected to be to a professional standard.

Individual project report – this is undertaken in year 4 and is the final and largest individual project during the whole programme. The written report, oral presentation, and the student's commitment and progress are all assessed bearing in mind the depth of understanding, the analytical and practical skills, and the knowledge of the subject demonstrated. The final written report and oral presentation (given as a poster and a presentation on the research stream) are expected to be to a professional standard.

This combination of assessment methods enables achievement of all the learning outcomes outlined in Section 17 to be demonstrated over the duration of these programmes.

Proportions of types of assessment by level can be found on the UniStats website: http://unistats.direct.gov.uk/

LEARNING OUTCOME (abbreviated – see Section 17 for full text)	**TEACHING/LEARNING**										**ASSESSMENT**							
	Lectures	Practical classes	Coursework assignments	Tutorials/examples	Industrial seminars/visits	Industrial Training	Miniprojects	Industrial placement	Individual research project		Written examinations	Coursework submissions	Laboratory reports	Oral presentations	Class tests	Group project report	Placement report	Individual project report
K1 Producer/user perspectives	·		·	·	·	·		·			·	·					·	
K2 Thermodynamics/kinetics	·	·	·	·			·				·	·			·			
K3 Structure	·	·	·	·			·				·	·	·		·			
K4 Key properties	·	·	·	·	·	·	·	·	·		·	·	·			·		·

K5 Characterisation techniques	·	·	·	·			·		·		·	·	·	·	·			·
K6 Technologies	·	·	·	·	·			·			·	·	·				·	
K7 Mathematics	·			·			·				·				·			
K8 Materials selection	·	·	·	·	·	·	·	(·)	(·)		·	·	·	·		·	(·)	(·)
K9 (a) & (b) Professional role	·	·	·	·	·	·	·	·	·		·	·	·	·		·	(·)	·
I1 Use/evaluate information		·	·	·		·	·	·	·		·	·	·	·		·	·	·
I2 Identify/solve problems	·	·	·	·		·	·	·	·		·	·	·	·	·	·	·	·
I3 Design/execute experiments		·				·	·		·				·	·		·		·
I4 Analyse/interpret data	·	·	·	·		·	·	·	·		·	·	·	·	·	·	·	·
I5 Plan research programme			·			·	·		·			·		·			·	·
I6 Function as a professional					·		·	·						·		·	·	
P1 Conduct experiments		·				·	·		·				·	·				·
P2 Convey information effectively		·	·	·		·	·	·	·		·	·	·	·		·	·	·
P3 Produce materials		·			·		·	(·)	·				·	·			(·)	·
P4 Use research tools		·				·	·	·	·			·		·		·	·	·
T1 Use IT effectively	·	·	·			·	·	·	·			·		·		·	·	·
T2 Communicate effectively			·	·		·	·	·	·		·	·	·	·		·	·	·
T3 Work individually/in teams		·	·			·	·	·	·			·		·		·	·	·
T4 Manage projects/people/time	·		·	·	·	·	·	·	·		·	·		·		·	·	·
T5 Learn independently			·			·	·	·	·		·	·		·		·	·	·

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 Vision and Strategic Plan
https://www.sheffield.ac.uk/vision

The requirements of the Engineering Council, and as used by the Institute of Materials, Minerals and Mining for the accreditation of degree programmes intended for potential Chartered Engineers.

20. Programme structure and regulations

The structure of the programmes in Materials Science and Engineering and its associated specialisms is modular. In each level students study modules worth a total of 120 credits.

In **Years 1 and 2**, the curriculum emphasis is on introducing the theories and concepts underpinning the selection, production, processing and use of materials. The programmes comprise mainly 10 credit and 20 credit modules. Individual courses have associated problems classes, tutorials and practicals. Students enrolled for both the materials and the specialised programmes may also take language in Level 1 as non-credit bearing modules and in level 2 options to the value of 20 credits per year.

In **Year 3**, the curriculum for all students includes management training. The modules taken in **Years 3 and 4** are biased towards developing a systematic, detailed and quantitative understanding of the competitive aspects of materials and their selection.

At **Year 4** all 120 credits of study are at Masters' level (M level as defined in the Framework for Higher Education Qualifications, 2001).

Industrial stream

In **Year 3** there is an emphasis on group project work through two ITPs. Students undertake a 5-month-long industrial work placement, in a relevant company (see also Section 23). The placement begins part way through Semester 2 and continues over the summer and can be carried out in either the UK or overseas. The Department assists in finding placements, helps to negotiate a suitable project, and monitor's progress. The placement contributes 10 credits to **Year 3** and 20 credits to **year 4** where a placement report and associated presentation are features of semester 1 along with a further ITP group project. **Year 4** is dominated by a 45-credit individual research project in the field of materials.

Research stream

In **Year 3** there is an emphasis on developing research skills through a series of mini-projects. **Year 4** is dominated by an 80-credit individual research project in the field of materials. A group work-based outreach project is also undertaken.

The mark awarded in the final degree for both streams is based on the results obtained in years 2 to 4 weighted in the ratio 1:2:2.

The first two years of this programme and that of the BEng programme in Materials Science and Engineering is common. **At the end of Year 2**, students may choose to transfer their registration to study for a BEng in Materials Science and Engineering or to continue on the MEng degree. Students enrolled on the MEng programme, who are not meeting specified progression targets, will be required to transfer their registration to that for the BEng degree. In **Years 3 and 4**, no changes of registration are allowed.

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

Year 1	Students will be introduced to the underlying concepts in materials science and engineering, namely**:** structure from atomic to macro scales; thermodynamics and kinetics; electrical magnetic and optical behaviour; mechanical properties of materials; aspects of materials selection, application and production. Practical sessions, demonstrations, works visits, tutorials, and worked examples classes will illustrate these principles and promote skills in measurement, evaluation and interpretation of qualitative and quantitative data for a range of materials. Students will be able to develop and present lines of argument and make sound judgements in accordance with these basic concepts. The course contents have been designed to ensure that all students reach a common level of understanding in Mathematics, Physics and Chemistry even if they do start with a strong background in one of these areas.
Year 2	Students will build on the materials concepts learned in the first year and continue to expand their mathematical, practical, analytical and presentation skills via lectures, worked examples classes, tutorials and practicals. Materials characterisation will be introduced as a new theme and the links between structure, processing and properties will be developed. Materials selection principles will be extended using the concepts of reverse engineering. Students will develop the ability to apply key concepts and skills in other contexts but will also have an understanding of the limits of their knowledge and how this influences analyses and interpretations based on that knowledge.

Level 3	Students will continue to develop a systematic and quantitative approach to materials science and engineering. This will include acquisition of coherent and detailed knowledge concerning processing, structure and properties for various materials, at least some of which is at, or informed by, the forefront of the discipline. New themes for modules will include interfaces, materials in combination such as composites, and enterprise and innovation. Students on the *industrial stream* will undertake extended project work, two ITPs and spend a significant period in industry working with an industrial mentor on an industrial problem, chosen to match the student's specialism where appropriate. Students' conceptual understanding will enable them to devise and sustain arguments and/or solve problems. They should appreciate the uncertainty, ambiguity and limits of knowledge and be able increasingly to manage their own learning using relevant literature and other media. Students on the *research stream* undertake a 30 credit mini-project. This takes place primarily in semester 2 and will constitute a sequence of guided experiments using equipment principally available with the Materials Teaching Laboratories within Diamond. Each project must contain key elements of research and development typically utilised in industry and academia and will follow the principal of 'Make, Measure, Model'. Guided report writing is an essential aspect of the mini-project and the student will be taught key writing, organisational and IT skills commensurate with a professional researcher in academia or industry. In addition the students on the research stream have 70 credits of option choices spread over 2 semesters which will allow them to focus on areas of future research interest and to supplement aspects of understanding in their mini-research project.
Year 4	Students on the *industrial stream* will complete their placement report and a third ITP will further develop their ability to apply knowledge creatively and critically, and present their conclusions effectively. Lectures will build on earlier principles giving students a systematic understanding of knowledge and a critical awareness of current problems. Much of this knowledge is at or informed by the forefront of research in materials science and engineering and students will gain a comprehensive understanding of techniques and research methodologies. They will use these to undertake an in-depth individual research project, so demonstrating that they can**:** carry out independent, original research; critically evaluate their own and others' results; and propose new hypotheses. Students on the *research stream* will utilise their comprehensive understanding of techniques and research methodologies gained in year 3 to produce high quality research embedded within the outstanding research groups in Materials. Here they will mix with PhD students and PDRAs on an equal footing as part of a comprehensive research team led by their academic supervisor. They will carry out independent, original research; critically evaluate their own and others' results; and propose new hypotheses. To supplement their understanding, they will take 2 x15 option choices which will develop aspects pertinent to their chosen research area. They will also gain an appreciation of the need for high quality outreach and the ethical requirements associated with research and development.

On successful completion of the programmes in Materials Science and Engineering:

Students will have obtained the necessary academic understanding to become a Chartered Engineer in Materials. Full Chartered Engineer status will require appropriate additional experience working as a graduate engineer. Students will be well prepared for a career in materials engineering or one of its associated specialisms, either in research and development or in production, as well as a wide range of other graduate careers. They will be able to assess whether they have the need, ability, motivation and interest to pursue postgraduate training in materials science and engineering or one of its associated subjects.

22. Criteria for admission to the programme

Applicants should have a strong background in two of Maths, Physics and Chemistry in GCE A levels or equivalent, with some knowledge, at least to GCSE level, for the third. A wide range of alternative qualifications is listed in the On-Line prospectus. The Materials Science and Engineering with a Foundation Year programme (MATU99) can provide a possible entry point to these programmes for students without this scientific background.

Students must also satisfy the general University matriculation requirements, including an acceptable English language qualification such as a minimum of grade C/4; IELTS grade of 6.5 with a minimum of 6.0 in each component; or an alternative acceptable English language qualification.

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

23. Additional information

Students on this programme may have opportunities to study abroad in either Europe or the US for one or two semesters in their second year.

Our close industrial ties facilitate compulsory industrial visits in year 1, the ITPs in years 3 and 4 of the *industrial stream* and joint final year projects. Our industrial visits form part of a Skills Week in Semester 1 of Year 1 that is also designed to demonstrate possible career directions and to develop transferable skills such as group project work and IT skills. Small bursaries may be available for industry-sponsored final year projects.

The 5-month paid industrial placement at year 3 is a major feature of the *industrial stream* of our programme. It offers valuable experience of a materials industry whilst simultaneously developing key transferable skills in a working environment; our students are widely appreciated by their employer's and many have taken up positions with their employers on graduation. Industrial placements may be undertaken in the UK or abroad. Overseas placements are typically in Europe or the US, although students have also gone to Australia, India and South America. The income earned during the placement can partly mitigate the cost of the fourth year of study on this programme.

On the *industrial stream* students are encouraged to spend one other vacation working in industry.

On the *research stream* students are encouraged to spend one vacation working in the Department as part of our research placement scheme that we operate from within the Department or as part of the SURE initiative.

Further details can be found on the Department's website at**:** http**:**//www.shef.ac.uk/materials/.

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.