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**	Biological and Bioprocess Engineering
2	**Programme Code**	CPET30 (Full-time)
3	**JACS Code**	H831, J700 (50/50)
4	**Level of Study**	Postgraduate
5a	**Final Qualification**	Master of Science in Engineering (MSc(Eng))
5b	**QAA FHEQ Level**	Masters - 7
6	**Intermediate Qualifications**	Postgraduate Certificate (PGCert), Postgraduate Diploma (PGDip)
6b	**FHEQ Level**	Masters - 7
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**	Biomedical Science, Materials Science & Engineering
11	**Mode of Attendance**	Full-time
12	**Duration of the Programme**	1 year
13	**Accrediting Professional or Statutory Body**	Institution of Chemical Engineers
14	**Date of production/revision**	April 2017, revised March 2018

15. Background to the programme and subject area

The Department of Chemical and Biological Engineering at Sheffield houses a unique bio-engineering centre with world-class capabilities. We have a core team of inherently multidisciplinary academic staff with primary research interests and expertise in bio-systems engineering and bio-processing. This Master's programme harnesses this knowledge base to provide a uniquely multidisciplinary learning experience relevant to the emerging discipline of biological engineering and careers in industrial bio-processing.

Biological engineering is emerging as a new branch of engineering where the core engineering design principles of measurement, modelling and manufacture are now being applied to complex biological systems, underpinning a new "systems biology". The fundamental challenge is to utilise and integrate fundamental genomic-level information to explain and predict the behaviour of complex biological systems. Applications are unrestricted, essentially any healthcare, environmental and life science problem can benefit from this approach.

Bioprocessing is a crucial part of the UK and global biotechnology/biopharmaceutical sector. For example, it is anticipated that within the next five to eight years up to 50% of *all* drugs in development will be biopharmaceuticals; a large proportion recombinant protein therapeutics. However, there is a global shortage of appropriately trained personnel able to contribute to the design and development of new bio-production processes. Application areas specifically relevant include novel manufacturing approaches for proteins and biopharmaceuticals, cell therapies, tissue engineering and gene therapeutics. As stated in a recent UK government report "development of bio-processing technologies will be pivotal to the future success of modern medicine".

Whilst based in the Department of Chemical and Biological Engineering, the programme also incorporates highly complementary teaching modules provided by a range of Sheffield's world-class departments (e.g. Materials Science & Engineering, Biomedical Science). The degree is accessible to both graduate engineers and bio-scientists, who will be provided with complementary interdisciplinary skills.

Further information about the Department and the programme 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 specific aims of the MSc in Biological and Bioprocess Engineering programme are to:

1. Provide access to an engineering degree to students from a range of academic and social backgrounds;
2. Prepare students for a professional career in industry, education, public and commercial sectors;
3. Develop interpersonal skills appropriate to a professional person;
4. Encourage students to think for themselves, work effectively on their own initiative, and develop a social awareness;
5. Provide experience in conducting extended individual projects;
6. Develop the students' ability to make technical decisions;
7. Provide students with an education through a firm understanding and practical knowledge in biological and bioprocess engineering;
8. Allow students to obtain a broad knowledge and deep understanding in biological engineering and bio-processing areas.

17. Programme learning outcomes

Knowledge and Understanding: Students will have developed knowledge and understanding of:	
K1	the science appropriate to the discipline of biological engineering and bio-processing;
K2	the impact of design on engineered bio-systems and bioprocesses;
K3	the biological and bioprocess implications of bio-engineered materials and components;
K4	professional and ethical responsibilities including the regulatory framework and the global and social context of biological and bioprocess engineering;
K5	the operational practice of bio-processing and integrated unit operations;
K6	Requirements for safe handling of engineered organisms and bioprocesses and the nature of the hazards;
K7	relevant biological knowledge and engineering practice and their limitations and an appreciation of likely new developments;
K8	the ability to integrate knowledge of bioscience, bioinformatics, biochemical engineering, bioprocess design, bio-analytical technology and the commercial context to solve a substantial range of bio-processing and biological engineering problems and issues.

Skills and other attributes

Intellectual Skills – students will be able to:	
I1	use scientific principles: in the development and analysis of bio-engineered systems; in the modelling and analysis of engineered bio-systems, processes and products;
I2	undertake biotechnical and bioprocess design evaluation;
I3	produce solutions to problems through the application of biological and engineering knowledge and understanding;
I4	make use of computer based models for solving problems in biological engineering and bio-processing, and be able to assess the limitations of particular cases;
I5	assimilate data from a wide range of sources, extract that which is pertinent to an unfamiliar problem, and apply this to a particular problem.

Practical Skills – students will be able to:	
P1	make use of relevant test and measurement equipment in experimental laboratory based research work;
P2	undertake practical testing of scientific hypotheses in the laboratory or through simulation, with technical analysis and critical evaluation of results;
P3	apply bioprocess design techniques taking account of industrial and commercial constraints;
P4	effectively manage their time in the context of research project;
P5	understand the engineering and bio-informatic tools related to biological and bioprocess engineering and apply and adapt them in unfamiliar situations;
P6	research and use new methods required for novel situations and adapt to specific purposes as necessary.

General Transferable Skills – students will be able to:	
T1	undertake manipulation, sorting and presentation of data;
T2	make use of scientific evidence based methods in the solution of problems;
T3	make use of general IT tools;
T4	work with limited or contradictory information and apply creativity and innovation to the solving of problems;
T5	manage time and resources and effectively communicate as a team member and demonstrate leadership skills;
T6	understand concepts from a range of areas, and the ability to apply them effectively in technical and business decisions;
T7	integrate effective presentation techniques and the information to be presented for maximum impact;
T8	work with the minimum of supervision, being proactive in their approach to learning and be able to: • be innovative in the use of a broad range of scientific principles in solving biological engineering and Bioprocessing problems; • develop, monitor and update a plan to reflect a changing technical and commercial environment; • monitor and adjust a personal programme of work on an on-going basis and can learn independently.

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.

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 classes – students undertake laboratory experiments and computing to gain practical skills.

Tutorials and example classes –to help students with their understanding and to resolve problems in their programme materials.

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

In most cases a combination of methods is used. Formal lectures are the principal means of imparting knowledge, and understanding is gained through a combination of tutorials, example classes and coursework assignments. Knowledge and understanding are primarily assessed in written examinations. However further knowledge and understanding is gained through project work and assessed in written reports and oral presentations. Skills are acquired mainly through coursework and individual or group projects.

The programme also provides a number of opportunities for personal development, including the interaction with those working in the field, during lectures and workshop sessions, and by encouraging responsibility in the decision making process, often when confronting complex industrial scenarios.

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.

LEARNING OUTCOME (abbreviated - see Section 17 for full text)	Teaching/Learning						Assessment					
	Formal Lectures	Formal Subject Tutorials	Practical Laboratory Classes	Individual Project Work	Private Study		Formal written examinations	Laboratory reports	Project reports	Individual presentations	Course Assignments	Personal Development
K1science appropriate to discipline	•	•		•	•		•	•	•	•	•	
K2 the impact of design	•	•		•	•		•	•	•	•	•	
K3 bio/process implications	•	•		•	•		•	•	•	•	•	
K4 professional and ethical responsibilities	•			•	•		•		•	•	•	
K5 operational practice of bio-processing	•	•		•	•		•	•	•	•	•	
K6 requirement for safe handling	•			•	•		•	•	•	•	•	
K7 relevant bio/engineering practice	•	•		•	•		•	•	•	•	•	
K8 the ability to solve problems	•	•		•	•				•	•	•	
I1 use of scientific principles	•	•		•	•		•	•	•	•	•	
I2 bioprocess evaluation	•	•		•	•			•	•	•	•	
I3 produce solutions to problems		•			•				•	•	•	
I4 use of computing packages		•		•	•			•	•	•	•	
I5 extract data & find solution			•	•	•		•	•	•	•	•	
P1 use of laboratory equipment				•	•			•	•			
P2 undertake testing of hypotheses		•	•	•				•	•	•	•	
P3 apply bioprocess design techniques		•		•				•	•	•	•	
P4 effective time management				•				•	•	•	•	
P5 apply bioengineering tools	•	•		•				•	•	•	•	
P6 research new methods	•			•				•	•	•	•	
T1 manipulation of data	•	•	•	•	•		•	•	•	•	•	
T2 use of scientific methods			•	•	•			•	•	•	•	
T3 use of general IT tools			•	•	•			•	•	•	•	
T4 working with limited data			•	•	•				•	•	•	
T5 resource management				•	•				•	•	•	
T6 understanding of concepts				•	•				•	•	•	•
T7 effective presentation techniques				•	•				•	•	•	•
T8 work independently				•	•				•	•	•	•

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

Written examinations – unseen examinations.

Coursework submission – designed to test knowledge and communication skills; these include technical design studies, critical reviews and extended analytical essays.

Oral presentations – The research projects and some taught modules include an oral presentation.

Individual project reports – these include intermediate and final individual enquiry dissertations and the research project, in addition to design project reports.

19. Reference points

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

Subject Benchmark Statements
http://www.qaa.ac.uk/assuring-standards-and-quality/the-quality-code/subject-benchmark-statements

Framework for Higher Education Qualifications
http://www.qaa.ac.uk/publications

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

Learning and Teaching Strategy (2016-2021)
https://www.sheffield.ac.uk/staff/learning-teaching/our-approach/strategy2016-21

'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 (as far as this pertains to postgraduate masters programmes).

Informed feedback from external industrial referees on research project design and assessment.

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

In common with most degrees at the University of Sheffield, the programme of study is modular in nature allowing students a certain level of flexibility in the design of their degrees. Postgraduate taught modules offered are usually 15 credits, which is nominally equivalent to 150 hours of work by a student. Of this between 30 and 40 hours are usually contact time and the remainder directed/private study. Credits are accumulated by obtaining a mark of at least 50 in the assessment for the module.

Students studying for the award of Masters are required to take modules to the value of 180 credits, comprising five compulsory 15-credit modules, a choice of three optional modules of 15 credits each, and a 60-credit supervised research project. The credits will be divided evenly between both semesters. Students who do not successfully complete the full Masters programme are eligible for either the award of Postgraduate Diploma if they have accumulated 120 credits from the study of taught modules or the award of Postgraduate Certificate if they have accumulated 60 credits.

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

21. Student development over the course of study

Students will study current issues at the forefront of Biological and Bioprocess Engineering. Their knowledge and understanding of professional issues and management will be enhanced. They will carry out an 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 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 and met the aims given in section 16.

22. Criteria for admission to the programme

The programme is designed for students with a first degree (or equivalent) in engineering or science, who wish to specialise or enhance their knowledge in the area of biological engineering and bio-processing technology either before entering the field or after gaining some practical experience.

Students will need an upper second class honours degree (2:1) in a relevant discipline, or equivalent qualifications and experience. Applicants with a 2:2 (or equivalent) are considered on merit. International students are also required to offer a suitable language qualification, such as TOEFL or IELTS (minimum overall score 6.5 with no individual score less than 5.5). Successful candidates may be required to attend an English Language course in the University before or during the programme.

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

23. Additional information

Further information is available in the MSc Biological and Bioprocess Engineering programme brochure from the Department of Chemical and Biological Engineering or online at http://www.shef.ac.uk/cbe/pg.

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 www.shef.ac.uk/ssid.