1	**Awarding Institution**	**Newcastle University**

2	**Teaching Institution**	**Newcastle University**

3	**Final Award**	**MSc**

4	**Programme title**	**Sustainable Chemical Engineering**

5	**Programme Accredited by**:	**N/A**

6	**UCAS Code**	**N/A**

7	**QAA Subject Benchmarking Group(s)**	**Engineering**
8	**Date of production/revision**	**July 2004**

9 Programme Aims:

The MSc Sustainable Chemical Engineering was set up in 2002 to address the needs of industry in recruiting students of Chemical Science or Engineering with a broad based understanding of sustainable engineering practices. The course has been designed to meet the growing need for engineers skilled in materials and process engineering and process intensification. The programme **aims:-**

- To train graduates who understand industrial processes to be aware of the potential of process intensification in sustainable engineering and possess the ability to develop, research and implement the methodologies in an effective manner.

- To allow disciplinary conversion of engineers or pure or applied scientists into sustainable engineering, where the students have an understanding of the environmental, economic and social issues associated with the operation of industrial processes and the need for, an application of sustainable technologies.

- To allow disciplinary conversion of engineers or pure or applied scientists into sustainable engineering, where the students have an understanding of the environmental, economic and social issues associated with the operation of industrial processes.

- To develop and improve the student's key skills alongside their academic and technical abilities. These include the ability to communicate and present effectively both orally and in writing, to work alone or as part of a team.

The programme offers the opportunity to work with leading edge researchers in the fields of new energy technologies such as fuel cells and gasification, process intensification and new advanced materials.

10(a) Programme Intended Learning Outcomes:

A **Knowledge and understanding**

1 of advanced process engineering and process intensification

2 of modern approaches to pollution detection, control and remediation

3 Advanced knowledge and understanding of the techniques that may used to minimise waste

4 Understanding of the principles of clean energy production as well as knowledge of cleaner technologies.

5 Advanced knowledge of new materials manufacture.

6 An awareness of the environmental, economic and social pressures put upon industry and demonstration of the means to achieve a more sustainable business

Teaching Strategy

Specialist knowledge and understanding is primarily imparted via lectures classes and seminars. This is supplemented by the use of industrially based case studies and workshops, and lectures from industrialists and environmental consultants. Students are also strongly encouraged to attend locally arranged seminars and conferences such as those offered by the School of Chemical Engineering and Advanced Materials and by the Energy Institute and IChemE.

Learning Strategy

Students are expected to carry out directed reading and appropriate reading lists are given on all module outline forms.

Active involvement in case studies and workshops increases the student's awareness of the issues and concerns of both industry and the public. Discussion and participation in lectures given by outside speakers, and attendance at local conferences, give students an appreciation of the real issues facing industry today as well as the requirement for an effective communication strategy.

Assessment Strategy

Knowledge and understanding are assessed by formal and class examinations and coursework and preparation of a Dissertation. Written unseen examinations include essays, short answer questions, equations and calculations. Assessed coursework comprises scientific/technical reports, design study calculations, essays, oral and video presentations and poster presentations.

The project element of the degree programme is assessed by Dissertation together with a poster presentation to which all examiners and lecturers are invited and where the external has the opportunity to talk to all of the students.

B Subject-specific/professional skills

The programme allows students to demonstrate:-

1. Analysis and problem solving skills in process intensification
2. Experimental, research and design skills through original laboratory research in new energy systems, materials and process intensification.
3. Creative and design skills in methods and planning of research.
4. Auditing skills for both general environmental auditing and energy auditing.
5. The ability to measure and monitor utilities, raw materials and waste arising during industrial processing and target strategies for reduction, reuse and recycle.
6. The ability to appraise and assess data from a wide variety of sources and apply appropriate statistical techniques.

Teaching Strategy

An understanding of the requirements and implementation of process intensification and sustainable engineering practice are taught within the *process intensification and process intensification of environmental processes, sustainable engineering and sustainable engineering and materials technology and* more extensively through the student's time spent on their methodology and planning of research module and a precursor to their individual research projects. In addition the various approaches taken by industry and commerce in addressing issues of sustainable development in a business context are widely demonstrated by the visiting lecturers. Environmental Auditing, Monitoring and Targeting and data management skills, are taught in the modules *Waste Management, Energy Management and Waste Minimisation.*

Learning Strategy

Students are given the opportunity to apply their acquired practical skills through class exercises and during their research projects.

Assessment Strategy

Specific understanding and application of the key skills is assessed through formal written examination, write ups of auditing exercises and the outcomes from the student research methodology and planning and research dissertations.

C Cognitive skills

The programme provides opportunities for students to develop and demonstrate ability to:

1. critically assess the value and limitations of process intensification, cleaner technologies and waste minimisation options.

2. solve problems and to be aware of alternative solutions which will ensure a more sustainable future based on environmental protection, economic viability and social acceptance.

3. process data, seeing trends and patterns and relate this to other variables

Teaching Strategy

Approaches to process intensification strategies are taught through the modules on *Process Intensification and Intensification of Environmental and Chemical Processes*.

Approaches to Advanced Process Engineering are taught through the modules of *Applications of Fluid Dynamics, Process Intensification and Intensification of Environmental and Chemical Processes*.

Approaches to waste minimisation and the potential applications and limitations of cleaner technologies are taught in the modules: *Sustainable Engineering, Design for a Sustainable Environment and Waste Minimisation.*

The ability to solve problems and evaluate sustainable solutions, is addressed in a number of modules where case studies are used such as*, Sustainable Engineering, Design for a Sustainable Environment.*

Data processing skills, are taught in *Statistics in the process Industries, Modelling and Simulation , Energy Management, Waste Minimisation* and through the design project that make up the coursework element of the wastewater modules.

Learning Strategy

Problem solving skills are employed across all elements of the course.
Students learn to handle and process data through practical exercises involving energy auditing and the design of wastewater treatment plants. Their projects give them many instances where they have to collect, collate and handle data from a variety of sources and apply appropriate statistical techniques.

Assessment Strategy

Assessment is by formal calculation/problem solving and essay style examinations, and coursework where the practical exercises and designs are written up. The ability to solve problems is a key element of case studies that form a large part of the course. .

D **Key (transferable) skills**

The programme provides opportunities for students to develop and demonstrate ability to:

1 communicate effectively and at all levels via written reports and oral presentations.

2 use library facilities and other sources of reference material

3 organise their workload and meet deadlines.

4 work efficiently and effectively either individually or in a team and where necessary to delegate or receive instruction.

5 analyse and understand a problem.

6. realise that there may be more than one solution to a problem and to select the most appropriate to meet sustainability requirements.

Teaching Strategy

The course can be taken by both science graduates and engineering graduates. For the former the programme offers modules in fundamental process engineering in the first semester to provide sufficient process engineering skills to meet the demands of the second semester programme. The latter is common to all students taking the programme.
Students are given dedicated seminars during induction week and later in the course prior to starting their projects on report writing, use of library facilities and working effectively both alone and as part of a team. This is also detailed in the course handbook. Particular attention to the handling of oral presentations, is given during the modules *Sustainable Processing and Materials, Technology and Sustainable Engineering* .
The ability to solve problems is covered in all case study based workshops and many coursework assignments and also using specific tools such as decision matrixes in *Design for a Sustainable Environment*. The course handbook goes into detail on the requirements of Dissertation writing and avoidance of plagiarism.
Team work skills are discussed prior to the initiation of each workshop and through participation in modules involving group presentations. Students are also given a seminar organised specifically for them by the Careers Department on presentation and interview skills and another on writing CVs.

Learning Strategy

Communication skills are assessed throughout the course when students are required to give oral presentations both alone or as part of a team. Feedback on these is given to the students who also have the opportunity to see themselves perform on video.
Problem solving individually or working as part of team is covered in workshops and case studies. The ability to see another person's point of view and communicate effectively is addressed during the workshops where students are required to role play.

Assessment Strategy

Key skills are assessed as a module component of the course, for individual and groups presentations and joint and individual written reports. Presentations are marked on their content, style and overall oral skills.

11 Programme Curriculum, Structure, and Features:

The programme of study begins annually in mid September and the taught element of the course ends in May. Students then carry out a research project, submitted in mid August which is usually based in the School and write a Dissertation of credit value of 60.

Candidates take modules to the value of 120 credits from one of the following two groups of modules, with the approval of the Degree Programme Director and depending upon the academic background of the candidate.

GROUP 1: for those candidates with an engineering background.

Candidates shall take the following compulsory modules:

Code	Course Title	Credits
CPE419	Process Intensification	10
CPE424	Bioreactor Engineering	5
CPE402	Sustainable Engineering	10
CPE441	Applications of Fluid Dynamics	5
CPE842	Sustainable Engineering	5
CPE872	Methodology and Planning Research	20
CPE803	Sustainable processing and Materials technology	5
CPE845	Intensification of Environmental and Chemical Processes	10
ENM309	Design of Experiment	5
CPE805	Modelling for Materials Sustainability and Processing	5
CPE808	Design for a sustainable environment	5
CPE896	Research Project	60

Candidates shall take optional modules from the list below to a total value of 120 credits.

Code	Course Title	Credits
CPE325	Chemical Process Optimization	5
CPE827	Modelling and Simulation	5
CPE830	Waste Minimization	5
CPE853	Research Methodology and Experimental Data Management	5
CPR857	Key Skills	10
CIV316	Wastewater Treatment	5
CPE829	Energy management	10
ENM236	Statistics in Process Industries I	5
ENM336	Statistics in Process Industries II	5

GROUP 2: for those candidates with a scientific background.

Candidates shall take the following compulsory modules:

Code	Course Title	Credits
CPE311	Separation Processes 2	10
CPE402	Sustainable Engineering	10
CPE817	Basic Chemical Engineering	10
CPE875	Reactor Engineering for Scientists	5
CPE803	Sustainable Processing and Materials technology	5
CPE871	Materials Processing and Technology	5
CPE805	Modelling for Materials Sustainability and Processing	5
CPE872	Methodology and Planning Research	20
CPE419	Process Intensification	10
CPE845	Intensification of Environmental and Chemical Processes	10
CPE808	Design for a sustainable environment	5
CPE896	Research Project	60

Candidates shall take optional modules from the list below to a total value of 120 credits.

Code	Course Title	Credits
CPE221	Heat Transfer 2	10
CPE133	Energy and Material Balances	10
CPE111	Fluids 1	10
CPE325	Chemical Process Optimization	5
CPE827	Modelling and Simulation	5
CPE830	Waste Minimisation	5
CPE853	Research Methodology and Data Management	5
CIV316	Wastewater Treatment	5
CPE829	Energy management	10
CPE857	Skills Module	10
ENM236	Statistics in Process Industries I	5
ENM336	Statistics in Process Industries II	5

The basic premise of the course is that it puts sustainable development in a chemical and process engineering context. So topics such as sustainability, resource use and especially energy, are common threads which run throughout the course although there is more detail in specific modules. Many modules run as workshop type formats where group investigative work is undertaken and the students can develop their communication and presentations skills. Some workshop presentations are recorded on video for the benefit of the participants. Design work is undertaken as part of the Design for a Sustainable Environment module and is a component of all waste and wastewater modules. All MSc students are offered a range of research projects, experimental, and theoretical from which they select a preferred field of study to investigate. The project is written up as a dissertation. A curriculum map which showing the fit between modules and learning outcomes is shown in Table 1.

Table **1. Curriculum map for MSc Sustainable Chemical Engineering**

Module	Codes	A1	A2	A3	A4	A5	A6	A7	B1	B2	B3	B4	B5	C1	C2	C3	D1	D2	D3	D4	D5
Industrial Wastewater Treatment	CIV316	X	X			X					X						X	X	X		
Separation Processes 2	CPE311	X						X	X				X						X		
Process Intensification	CPE419	X						X	X	X	X	X	X		X			X	X		
Reactor Engineering for Scientists	CPE875						X	X	X		X		X						X		
Bioreactor Engineering	CPE424						X	X	X	X		X	X						X		
Application of Fluid Dynamics	CPE441						X	X	X	X	X		X		X			X	X		**X**
Energy Management	CPE829			X		X				X	X	X				X	X	X	X		
Waste Minimisation	CPE830			X	X						X	X		X		X		X	X		
Sustainable Engineering	CPE402			X	X		X		X					X	X		X	X	X	X	**X**
Intensification of Environmental and Chemical Processes	CPE845				X						X						X	X	X		
Design for a Sustainable Environment	CPE808			X	X		X				X			X	X		X	X	X	X	**X**
Methodology and Planning Research	CPE872					**X**	**X**	**X**		**X**	**X**		**X**		**X**		**X**	**X**	**X**	**X**	X
Sustainable Processing and Materials Technology	CPE803					**X**	**X**	**X**									**X**		**X**		
Basic Chemical Engineering	CPE817	X		X				**X**				**X**				**X**	**X**	**X**	**X**		
Intensification of Environmental and Chemical Processes	CPE845			X		**X**	**X**	**X**	**X**	**X**				**X**	**X**		**X**		**X**		
Modelling and Simulation	CPE827			X		X		X	X	X	X	X	X			X			X		X
Modelling for Materials sustainability and processing	CPE805					X	X	X	X	X	X	X	X		X	X	X		X		
Chem Process Optimisation	CPE325					X		X		X		X				X			X		
Research Methodology and experimental data management	CPE853					X	X	X			X	X	X	X	X	X	X	X	X		X
Key Skills	CPE857							X									X	X	X		X
Statistics in Process Industries	ENM236					X						X			X				X		
Heat Transfer 2	CPE221							X											X		
Fluid1	CPE111							X											X		
Design of Experiments	ENM309					X	X					X			X				X		X

Key for symbols used in Table 1.

A **Knowledge and understanding**

A1. Advanced knowledge and understanding of pollution sources and impacts on the environment
A2. Knowledge and understanding of modern approaches to pollution detection, control and remediation
A3. Advanced knowledge and understanding of the techniques that may used to minimise waste
A4. Understanding of the principle tools and techniques used for clean design and manufacture as well as knowledge of cleaner technologies
A5. Fundamental concepts in modelling and optimisation.
A6. Demonstrate a knowledge of the latest research and technology developments which can be applied to a research topic.
A7. Demonstrate knowledge and understanding of chemical engineering principles

B Subject-specific /professional skills

B1. An understanding of the principles of chemical engineering applied to sustainable technologies.
B2. Analyse data and develop process models
B3. Ability to use commercial computer packages.
B4. The ability to appraise and assess data from a wide variety of sources and apply appropriate statistical techniques.
B5. Solve problems requiring original thought

C Cognitive skills

C1. The ability to critically assess the value and limitations of cleaner technologies and waste minimisation options
C2. The ability to solve problems, bearing in mind there may be more than one solution and the chosen one must be that which will ensure a more sustainable future based on environmental protection, economic viability and social acceptance.
C3. The ability to process data, seeing trends and patterns and relate this to other variables such as production figures

D Key (transferable) skills

D1. The ability to communicate effectively and at all levels via written reports and or oral presentations.
D2. The ability to use library facilities and other sources of reference material
D3. The ability to organise their workload and meet deadlines.
D4. The ability to work efficiently and effectively as part of a team and where necessary to delegate or receive instruction.
D5. The ability to analyse and understand a problem and realise that there may be more than one solution, choosing that which is most appropriate in the circumstances.

12 Criteria for Admission:

The programme is suitable for students with a good degree, (2:2 minimum or equivalent), in engineering or a pure or applied science subject. Students must also fulfil language requirements and provide satisfactory references.

Alternative entry qualifications

Students with a lesser qualification but relevant industrial experience may exceptionally be accepted on merit.

Admissions policy

On enquiry to the Course Director, or on receipt of application, a letter or email is sent with full details of the programme and a copy of the current year's handbook. Applicants are invited to visit the school and / or enter into correspondence with the Course Director should they need more information.

13 Support for Students and their Learning:

Induction

The induction programme is largely common to all postgraduate MSc courses within the school and includes introductions to library and IT facilities and talks on safety. Overseas students have an additional welcome session where information is provided on specific issues such as language support. In addition the students have a half day session with the course director in which they are given specific information relating to the course.

A particularly useful feature of induction week has been the opportunity for students to attend the poster presentations of students from the previous year which allowed students to meet and discuss the course and see the quality and type of project they would be working on themselves for their Dissertations. Due to the earlier termination for all MSc programmes from 2004 this will no longer be possible.

Learning resources

These include the following :-

- Degree Programme Director (who also acts as personal tutor to all students)
- Project Supervisor
- Initial Induction programme
- Web based information including degree regulations
- Dedicated web sites for the course where lecture material is posted.
- University Computing Service facilities (including extensive PC and UNIX provision, software applications, e-mail and internet access);
- University (Robinson) Library, including search facilities and inter-library loans;
- Private study area in Merz Court
- Laboratory Facilities;
- University Careers Service;
- University Counselling Service;
- University Language Centre;
- Students' Union services, including societies, refectories and Student Advice Centre, further student refreshment and social areas are available in Merz Court;
- Centre for Physical Recreation and Sport;
- Student Progress Office;
- International Office;
- University Chaplaincy;
- Disability support unit
- Campus Medical Practice.

IT and Library facilities are provided by the University and School. Course lecture notes are provided on the web at two dedicated web addresses for the degree programme and via blackboard.

Most teaching where possible is possible in small groups with students having ample opportunity to interact with lecturers. Lectures are provided by staff from across the Faculty with an overall staff/student ration of approx 1:12.

Students have access to dedicated PC cluster reserved for postgraduate usage.

Academic support

Each student is supervised overall by the Course Director. Supervision of research projects is carried out by one academic from the school usually together with one of his research assistants. Other members of School research groups, are available to mentor students when required.

Pastoral support

Each student is tutored by the Course Director. Pastoral care is also provided by the University Student Office. Students on the programme are actively encouraged to work and socialise together. This helps with their integration to the programme and the University as they are from diverse ethnic and academic backgrounds. Trips out and social events are arranged.

Support for Special Needs

Special need students are fully supported within the School in line with University Policy.

14 Methods for evaluating and improving the quality and standards of teaching and learning:

Mechanisms for review

- Annual report to faculty teaching and learning committee.
- Module Review (including University Questionnaire Service returns)
- Annual Revision of Module Sheets
- External Examiners' Reports to VC
- Student/Staff Committee
- Board of Studies
- Personal Tutors

Committees with responsibilities for quality and standards

- Faculty Postgraduate Teaching and learning Committee
- School Postgraduate Teaching and Learning Committee
- Board of Studies
- School Executive (for resource issues)
- School Staff/Student Committee
- Board of Examiners

Staff Development activities

- All new academic staff complete Certificate in Learning & Teaching
- Annual Board of Studies review of module delivery

Module reviews

Student evaluation of the programme is an important component of our quality control and is gathered using anonymous questionnaires which evaluate not only each individual module and the lecturers concerned but also the structure and content of the course overall. In addition students are encouraged to see the Course Director immediately should there be any specific issues with any module so that these can be resolved quickly. Feedback from forms is used by the Board of Studies to modify the course where required and comments are fed back to the lecturers. Issues may be raised at any time with the Course Director or any be fed through to the Board of Studies via the Staff students committee.

Programme reviews

The programme as a whole is periodically reviewed in the light of:_

- Student feedback
- Feedback from the External Examiner including his yearly reports
- Relevance to the key developments in the area of the programme,
- Relevance of the programme in relation to employability of graduates

Faculty and University Review Mechanisms

Committees Responsible for Monitoring and Evaluating Quality and Standards are as follows:-

- University teaching Committee
- Faculty Teaching Committee
- Board of Studies
- School Post graduate Teaching and Learning Committee
- Staff students committee
- Board of Examiners

15 Regulation of Assessment

The programme is assessed by means of coursework, formal or class written examinations, (highlighted by * in module list), workshops and project work, (both individual and group) written and oral presentations and a Dissertation. The pass mark for all modules is 50%. Where students are assessed by written examination there is usually an additional coursework component. The Dissertation is double marked and where they is a discrepancy of >10 marks a third marker is appointed.

Formal examinations take place at the end of semester 1 and after the Easter vacation at the end of the second half semester. The results are considered by the Board of Examiners which includes the

External Examiner. Under Faculty Regulations students may be allowed to attempt one resit. After the meeting of the Board of Examiners the Examiners may recommend:

a) The student should pass
b) Should pass provided minor corrections or improvements are made
c) Should rewrite or improve a significant portion of the thesis or resubmit totally
d) The dissertation is not up to an MSc standard but the student is registered for an MSc. The student may be awarded a Diploma
e) Has not shown sufficient effort, knowledge or understanding for the award of the MSc/Diploma and may not resubmit

Note that a Distinction may be awarded to students chosen by the Examiners on merit. An overall mark of ≥ 70% is required for a distinction. Students with an overall mark of 60 % may be awarded a pass with merit.

Role of the External Examiner

The External Examiner is appointed for three years and is a distinguished member of the science and engineering community whose knowledge spans the range of subjects and areas covered in the course.

Specifically he/she is required to :-

- See and approve exam scripts
- See marked scripts and coursework
- Interview all students at the Dissertation oral\and poster presentation session
- Perform viva voce examinations if required.
- Examine all Dissertations
- Attend Board of Examiner's meetings
- Prepare an external examiner's report

16 Indicators of Quality and Standards:

Professional Accreditation Reports
Not applicable

Information concerning the programme
Key sources of information about the programme is provided via:

- The University Prospectus
- The School Prospectus
- The University and Degree Programme Regulations
- The Degree Programme Handbook
- University Blackboard
- The Programme website http://lorien.ncl.ac.uk/ming/dept/swot/envnotes.htm.