MSc in Process Engineering - Programme Specification

Name of University: **Queen's University Belfast**

School: **Chemistry and Chemical Engineering**

1. Course Philosophy and High Level Objectives

The MSc Programme's aims, with respect to the teaching services it provides, are:

i. to offer students a high quality teaching programme which equips them with the necessary understanding and range of skills to undertake careers as professional chemical and process engineers allowing progression towards the status of Chartered Chemical Engineer;

ii. to ensure longevity of students' education by providing a balance between instilling fundamental principles and imparting professional skills to develop life long learning;

iii. to provide an active learning environment in which students are encouraged to take responsibility for their own learning;

iv. to provide postgraduate degrees whose content and standards compare favourably with those awarded by other national and international Chemical Engineering departments, as judged by external examiners, accreditation by the appropriate professional body (IChemE) and coverage of the subject as defined by the QAA Engineering Benchmark Statement;

v. to attract an increasing number of high quality students into the discipline;

vi. to retain a strong research ethos in the School, both by ensuring academics have time to focus on undertaking research, and by ensuring that module content is influenced by research where appropriate and is in keeping with the University statement on research informed teaching.

The Intended Learning Outcomes of the degree provision are set out in Programme Specifications for the degree Programmes and the Benchmarking Statement, and fall into the Main Educational Outcomes of:

(i) knowledge and Understanding;
(ii) intellectual Skills;
(iii) practical Skills
(iv) general Transferable Skills

1.1 General Strategy

The MSc course is and consists of 9 module credit (180 Cat points), delivered over two twelve week semesters, with 3 module credit per semester and a summer research/design project of 3 module credit.

The Process Engineering curriculum is designed to be consistent with the Engineering Benchmark Statement and our Programme Specification.

1. To develop the intellectual, practical, and professional skills of the learner in the critical acquisition, analysis, interpretation and understanding of process engineering principles and issues in preparation for:(i) a career in the process, consultancy, regulatory, management, and engineering industry; (ii) a position of leadership early in that career; (iii) further study; (iv) life-long learning and an appreciation of the value of Process Engineering to a sustainable society.
2. To develop critical and analytical problem solving skills across a broad range of subjects and transferable skills that relate to literacy, numeracy, computing, team-work, group work, and personal presentations and interactions to prepare graduates for more general employment.
3. To introduce key concepts of management, sustainability, sustainable development, and risk-based approaches to the Environment and Engineering.

The MSc programme contains either independent design or research project and thesis undertaken by the MSc candidates following the taught programme. Project work provides opportunity for students to independently formulate ideas and concepts and to communicate them in a clear and supported manner.

1.2 MSc Strategy

The intended learning outcomes for MSC courses have been devised in keeping with IChemE guidelines and the Engineering Benchmarking Statement. The MSc course is distinguished principally by: extending transferable and employability skills, via courses in Energy, Quality, Safety & Environment Management, Economic Management and Biological and Pharmaceutical Processes (CHE8014, CHE8005, CHE8007, CHE8013)**,** enhanced (deepening) study, Advanced Catalysis & Chemical Engineering (CHE8011); Polymer Engineering (CHE8006) enhanced extended skills Computer Simulation (CHE8009); Advanced Oil & Gas Process Engineering (CHE8017), and substantial open-ended projects, Design or Industrial Project (CHE8019, CHE8018), which stretches and develops students' problem solving and creative thinking skills.

2. Course Entry Standards

Entry standards are comparable to those in other comparable universities

For MSc minimum entry requirement is a 2(ii) UK Honours-equivalent first degree in a relevant engineering/scientific discipline with sufficient mathematical background in their training

For international candidates, at least a British Council IELTS qualification scored at a standard of 6.0. TOEFL scores (less preferred) are accepted with thresholds of: 577 (paper); 233 (computer).

Applications from overseas students and from further education establishments not offering the above are considered on a case-by-case basis provided the prior learning can be mapped to an appropriate entry point.

3. Learning Outcomes

3.1 Background

The main vehicle for communicating Aims and Intended Outcomes to the students and staff is through Modular Course in Chemical Engineering or "Blue Book", which outlines the module learning outcomes and skills acquired. Students are given a copy of the "Blue Book" on enrolment, which also contains the regulations for all our degree programmes. The skills acquired in each module are explicitly stated and have formed the basis of the "Intended Learning

Outcomes" for our Programme Specifications. They are also consistent with the Benchmarking Statement on Engineering. The School has progressed from an Aims & Objectives teaching model to a Learning Outcomes one.

A variety of methods have been employed in communicating programme aims and intended outcomes to the various stakeholders (applicants, students, parents, schools, employers, professional bodies and staff). For example, the University prospectus, leaflets and careers' conventions are primarily intended for potential applicants, careers advisors and parents; pathway regulations and module descriptions (proformas and module outlines) are primarily for students and staff. A further example in communicating intended outcomes concerns laboratory based teaching and laboratory based project work, when our students are required to undertake an induction course on laboratory practice and health and safety. Students are made aware of pre-requisites for membership of corporate bodies (IChemE and Engineering Council), such as passing the Design Project and gaining at least an MSc pass degree.

The Intended Learning Outcomes of our degree provision are set out in Programme Specifications for the degree Programmes and the Benchmarking Statement, and fall into the Main Educational Outcomes of:
(v) Knowledge and Understanding;
(vi) Intellectual Skills;
(vii) Practical Skills;
(viii) General Transferable Skills.

These Main Educational Outcomes are applied to the six aspects of engineering as outlined in the Engineering Benchmark Statement (Science, Information Technology, Design, Business Context, and Engineering Practice) to form the Intended Learning Outcomes for our degree provision.

4. Learning Outcomes – MSc Level

4.1 Depth

There are three main elements enhancing the knowledge and applications of chemical engineering at MSc level are: Advanced Catalyst and Reaction Engineering (CHE8011); Analysis & Computer Simulation of Chemical Processes (CHE8009); Polymer Engineering (CHE8006) and the Design/Research Projects (CHE8018/19).

Advanced Catalysis and Reaction Engineering (CHE8011)

This MSc research led module expands on previous chemical engineering principles of reactor development, introducing additional aspects of design by computational methods. To enable analysis of data and its application to optimum chemical reactor design in deactivating catalytic systems. It incorporates aspects of industrial chemistry by joint lectures with chemistry students on areas of catalyst development and through analysis of case studies. A project involves students working together in small groups in which Chemistry and Chemical Engineering students will solve process design problems, based on real industrial cases, using skills from their own disciplines and information gained during this course. The teams present their solutions to the problems in a short oral presentation.

Acquired are enhanced skills and knowledge regarding the design of multi-phase chemical reactors and experience in interdisciplinary approach to solving specialty chemistry case studies.

Analysis & Computer Simulation of Chemical Processes (CHE8009)

The MSc students acquire enhanced knowledge and skills in implementing numerical methods, modeling, computer method and programming for advanced analysis. Also involved is the simulation of complex chemical processes and to appreciate computing methods and software toolboxes in problem solving, process optimization and design. This involves applied numerical methods for engineers (MATLAB), computing methods and systems of partial differential equations (COMSOL), advanced software tools for analysis and simulation (Aspen).

Advanced Oil & Gas Process Engineering (CHE8017)
Students gain in depth knowledge on modern oil and gas economics, upstream oilfield processing, crude phase separation, desalting, demulsification, crude distillation, catalytic and hydro cracking, reactor design with numerical simulation, hydrogen production, renewable energy, and sustainability.

Research Project (CHE8018)

The Research Project is a substantial open-ended project which stretches and develops students' problem solving and creative thinking skills. The student carries out an in-depth experimental project in the laboratory. Students work individually on a project throughout the second and summer semesters. During the first 7 weeks of semester two, the students undertake an in-depth literature survey and feasibility study culminating in a report and presentation of the work. The rest of the semester is devoted to the design and assembly of a laboratory scale experimental rig. Any additional equipment and consumables are ordered during this period allowing for immediate experimentation to begin at the commencement of the second semester. A final report and poster presentations are submitted at the end of the semester along with a final in-depth oral presentation during the student has to defend the work to a panel of academic staff.

Design Project (CHE8019)

In the Design Project the learning outcomes are specific in the design projects in module (CHE8019) which develop knowledge and understanding, intellectual, practical and transferable skills within the context of design.

Design Project Section 1
The MSc cohort is divided into small groups. The project is sub divided into 5 phases spread over the first part of the summer semester.
Phase 1 involves the research of various routes of manufacture for a product, and to determine the optimal synthesis and the unit operations for the manufacture of the chosen product.
Phase 2 specifically allows the students to demonstrate an integrated approach in the application of fundamental quantitative and computing knowledge in the calculation of detailed heat and mass balances. Aspen simulation is used to verify hand calculations.
Phase 3 involves the application of the commercial and social skills in assessing the economic viability of the project.
Phase 4 allows the students to demonstrate fundamental chemical engineering knowledge to the design of a specific unit operation.
Phase 5 is dedicated to the application of the systems knowledge in analysing and developing control strategies for process control.
Presentations, interviews and peer/self assessment are an integral part of the transferable skills of the project.

Design Project Section 2
The objectives are to carry out detailed design procedures on an existing plant design brought up to the process flow diagram stage with the skills acquired to enable the plant design to be completed to the stage of construction. Five phases are again employed allowing students to demonstrate the acquired chemical and mechanical skills applied to: phase 1mechanical design of a unit operation; phase 2 site selection and plant layout; phase 3 critical path analysis; phase 4 integrated pollution control, waste minimization and effluent treatment; and phase 5 safety.

Presentations and peer/self assessment are an integral part of the transferable skills of the project.

4.2 Breadth

The MSc pathway gives added breadth in the specialist management related topics Energy, Quality, Safety and Environmental.

Energy and Quality Management (CHE8017)

The module provides an increased in breadth of understanding of energy utilization in network analysis and operability of projects and to develop awareness in energy management principles and energy conservation schemes. Additional skills are acquired in quality management through problem identification and solving, statistical process control and the implementation of costing programmes.

Safety & Environmental Management (CHE8005)

The MSc students acquire increased breadth of knowledge and understanding of safety and environmental issues relevant to the chemical and process industries. Focus of the safety management is on fire and explosions and circumspect design. Students address environmental awareness through the main issues of waste disposal, recycling, clean technology and waste minimization for solid, liquid and gaseous effluents. Case studies, essays and presentations on major environmental accidents broaden the learning outcomes of the MSc students.

Management and Economics (CHE8007)

The provision of management and administration delivered primarily given through module Management and Economics (CHE8007) provides the knowledge and ability for an appreciation of financial and management techniques in projects and within company structures, with special reference to plant costs, investment appraisal and uncertainty and risk in economic evaluations. The skills learned during this module are applied during projects especially the design project.

Biological & Pharmaceutical Process Engineering (CHE8013)

Students gain knowledge on the engineering application of microbiology, enzyme and cell kinetics to bioprocess design & operation. Biomedical applications of oxygen transfer in blood vessels, biomaterials for tissue engineering.

4.3 Increased Skills and Project Work

An essential element throughout many of the advanced MSc modules is oral and written communication, the assessment of which will be directly within the module. Opportunities exist for the students to demonstrate enhanced and extended specialist knowledge in the Design Project and Research projects, and in projects in modules Analysis & Computer Simulation of Chemical Processes (CHE8009); Advanced Chemical Engineering (CHE8011).

Design Project

In the Design Project sections 1 & 2 (CHE8019) a recent development in the course is to encourage the students to research various routes of manufacture for a product at the beginning of the project, and to determine the optimal route for the process. It is believed that the design project encourages the students to take responsibility for their learning and develop “excellent” problem solving skills in “generating new ideas and to developing and evaluating a range of new solutions” (Engineering Benchmark Statement), and allowing students to demonstrate creative and critical powers by requiring choices and decisions to be made in areas of uncertainty.

Analysis & Computer Simulation of Chemical Processes (CHE8009)

Students apply specialist knowledge to the MATLAB simulation of complex chemical processes such as the dilute solid-liquid two phase flow in circular pipes using Yang’s models, the production of oxygen enriched air by gas permeation with dense polymer membranes. FEMLAB simulations are undertaken on porous reactors with injection needle. The model treats the flow field and species distribution of heterogeneous catalysis. Acquired are enhanced skills and knowledge regarding modelling and simulation of system equations in linear, non-linear, ordinary differential, partial differential, data regression, optimisation and statistical analysis of error, particularly in relation to chemical thermodynamics, reaction kinetics, reactor design, transient state heat/mass transfer, coupled transport and reactions in reactors and separators based on multi-physics approach in solving mass, momentum and energy conservation equations described in partial derivatives.

Advanced Catalysis and Reaction Engineering (CHE8011)

Building on previous modules in reaction engineering and analysis and simulation of chemical processes, the module aims to continue to develop creative thinking through projects based on catalytic process problems and batch plant design. The major project element is a joint design problem of a batch fine chemical. Here groups of final year chemists and MSc students are brought together in groups (normally 2 engineers and 4 chemists) to carry out a retro synthesis of a target chemical (e.g. Fenoxoprofen). From a given raw material the students have to develop a number of possible synthetic routes and perform an environmental and cost analysis to identify a suitable pathway. Aspen batch is used for estimating physical properties and for carrying out the heat and mass balances. Finally the students are required to present their finding to a mixed chemistry and chemical engineering panel.

Research Project (CHE8018)

The creation of the new School of Chemistry and Chemical Engineering provides opportunities for the MSc students to undertake research at the interface between science and engineering. The collaboration between chemists and engineers provides a unique environment for collaborative research which is organised into three themes: Catalysis (CenTACat), Synthetic and Bioorganic Chemistry (SynBIOC), and Innovative Molecular Materials (IMM), with strong links to Environmental Science and Technology (QUESTOR), Green Chemistry (QUILL) and Environmental Engineering Research (EER). Other research groups in which the students work are the Polymer Processing Research Centre (PPRC) and the Medical Polymer Research Institute (MPRI). Each project is unique to the student who will be placed in an active area of one of the above research clusters.

The projects are structured to develop and assess the students’ intellectual, professional and practical knowledge of chemical engineering fundamentals. Time management, presentation and written skills are enhanced by the initial feasibility study and the final report, oral and poster presentations, and management of equipment and consumable supplies.

5. Overall Course Structure and Weightings

The MSc pathway is a one Stage modular programme operating in two academic 12 week semesters per year with the examinations held in a 3 to 4 week period after each semester. Each year is divided into 6 taught module credits (120 Cat points), normally 3 module weight per semester. In addition the MSc pathway contains a summer semester (60 Cat points) of the Design or Research project.

Extended Study	
Reaction Engineering	10
Energy & Quality Management	10
Environment Engineering, Safety & Management	20
Management & Economics	20
Biological & Pharmaceutical Process Engineering	20
Enhanced Study	
Design Project	60
Advanced Catalysis and Reaction Engineering	20
Analysis & Computer Simulation of Chemical Processes	20
Advanced Oil & Gas Process Engineering	20
Extended Skills	
Research Project	60

7. Assessment and Quality Assurance

7.1 Assessment Strategy

School's Learning and Teaching Strategy is entirely consistent with the University strategy with respect to: learning; teaching; assessment and quality management. Evidence for the compatibility of the School's and University's strategies can be found in the School's: programme specifications and module handbook. The following learning outcomes are explicitly assessed:

- Knowledge and Understanding: mainly through examinations;
- Intellectual Skills: through examinations, and through project work;
- Practical Skills: mainly through continuous assessed practical and project work;
- Transferable and Employability skills: through reports, presentations and interviews on projects; and on the professionally oriented modules.

The students are made aware of the method of assessment at the beginning of each module; this is articulated by teaching staff and explicitly stated in the "Blue Book". There is a variation in the percentage of coursework required for each module, but this is reflected in the nature and of the module.
The University operates anonymous marking procedures for formal examinations. Anonymity is only revealed by the examination officer. Design and research reports are marked by a minimum of two members of staff.

7.2 Examinations

- Details of the dates of degree examinations are published by the University Examinations Office.

Examinations for the Degree of MSc

- Examinations are normally held in the three weeks after each semester.

7.3 Awards, Credits and Progression of Learning Outcomes

Examinations

Module assessments have the following characteristics:

Assessment criteria linked to learning outcomes for each module.

Overall ratio of coursework: unseen examinations 50: 50.

Assessment is carried out in January and May.

Pass mark for MSc is 50% in all modules.

7.4 Degree Assessment

Diploma students, who achieve at the first attempt an MSc standard of performance in coursework and examinations, will be invited by the Board of Examiners to transfer to the MSc pathway.

Pass mark for Diploma is 40% in the compulsory modules and an average of 40% over all the taught modules.

Students on the MSc programme, who have achieved a minimum of 50% in the compulsory modules and an average of 50% or greater overall in the taught programme, are required to undertake a project and submit a dissertation in September. This dissertation must be passed at 50% for the award of the MSc. Students who achieve an average of 70% in both taught modules and research/design projects will be awarded Distinction.

Students on the MSc who fail to achieve 50% in the compulsory modules, an average of 50% in the taught component, or 50% in the dissertation, will be considered for a Diploma. There is no right of resit for MSc candidates.

Students who fail to achieve the award of Diploma may resit failed modules at the next opportunity.

7.5 Maintenance and Enhancement of Standards and Quality

All programmes are subject to the Curriculum Review and Development procedures detailed in the University Quality Handbook.

7.5.1 Pass Rates and Progression

The pass rates and progression rates in Process Engineering are at 100% and very high compared to other Schools within Queen's University. Evidence gathered through Staff Student Consultative Committee (SSCC) and Module review indicates that this may be due to small class sizes facilitating interaction and enhancing skills attainment.

7.5.2 Student and Staff Feedback

In line with University policy, the School each year establishes a Staff/Student Consultative Committee (SSCC). The Committee meets at least three times per year and provides a forum for staff and students to discuss aspects of the quality of academic provision and day-to-day matters relating to the learning and teaching activities within the School. Through the SSCC, students have complete access to Module and Pathway Review reports, with the minutes of these review processes discussed at SSCC meeting. Students are also encouraged to give feedback on the review process. The SSCC is also consulted on all course development and regulation changes. An Academic Board was constituted in 2001 to offer a central staff student consultative forum where students can raise issues related to central provision of learning and teaching. A member of staff and student from the School will be on this board.

Good practice from the SSCC includes: examinations officer on committee (to answer queries on assessment); student representatives from each year asked to comment on all aspects of the provision (good or bad), actions requested by student representatives are followed up by academic members, separation of undergraduate and postgraduate SSCC, allows more time to focus on specific issues.

Towards the end of each module students are requested to provide feedback on the quality of teaching and support provided and on the academic content of the module. Feedback is gathered by means of a range of anonymous questionnaires. A ‘Lecturer Evaluation Questionnaire’ invites students to comment on the teaching and support provided by the lecturer in charge. The questionnaire is analysed by the lecturer and the results are privy to the lecturer and the Head of School. Overall, within the School, the results are encouraging with many lecturers regularly scoring above 4 on a 5-point scale and no one scoring below 3.

7.5.3 The Quality Loop

Module review takes place at the end of each semester, during which a member of staff has an open discussion with normally all students in each stage. The School believes that this process is the best method of conducting Module Review as it creates a forum in which every student within the School has an opportunity to comment on the quality of specific modules and of the entire subject provision. During the discussion the students are asked specifically to comment on: the intended learning outcomes; curricula and assessment methods and the quality of learning opportunities for each module in that semester. Minutes of the Module Review meeting are sent to the SSCC for comments on their accuracy and content, and are then presented to the School’s Teaching Committee which includes all academic members of staff. The Staff have the opportunity to comment on the Module Review at this stage. Minutes of the Module Review meeting are also sent to service teaching Schools where appropriate.

A Pathway Review meeting is held at the end of each academic year (chaired by the Head of Teaching, and attended by the Chair of the School’s Teaching Committee) in which the entire subject provision is reviewed. Evidence from: module review meetings; School's Teaching Committee minutes; the School’s examination Boards minutes, SSCC minutes and evidence from service teaching Schools are used. Minutes from the Pathway Review meeting are presented before the beginning of term to Staff via the Teaching Committee and to the Students via the SSCC.

The Quality Loop described above ensures that both Staff and Students are fully informed about Quality issues and have opportunities to become involved in the enhancement of the quality of the subject provision. We believe that this process is both clear and transparent and that throughout the process both students and staff receive feedback on the both Module and

Pathway Review. The timing of the review process gives opportunity for individual members of staff to become “Reflective Practitioners” for their module provision.

7.6 External Examiners

The external examiners play a vital role in the maintenance of standards:

- moderate all draft examination questions;
- audit a range of examination scripts, essays and extended dissertations;
- check the accuracy and consistency of marking;
- submit reports on examination procedures.

8.0 MSc Degree Classification

The classification of the MSc degree is based on the weighted average marks of all modules, and individual mark of research/design project.

Mark Interpretation

- 70% and above in average marks of all modules, and also 70% or above in research/design projects — 1st class Honours
- 70% and above in average marks of all modules, and 50% <70% in research/design project — MSc degree with commendation
- 50% and above in average marks of all modules, and >50% in research/design project — MSc degree with commendation
- 50% and above in average marks of all modules, and <50% in research/design project — Diploma

Students who failed to achieve an average mark 50% in 6 taught modules will graduate with diploma without conducting the research/design programme for MSc degree.

The mark for each module, which will be used in the calculation of Honours classification, will be the mark achieved at the first attempt of the module, except where the module was passed at a second or subsequent attempt, in which case the maximum mark used will be 50%.