JBM Guidelines for MScs and Programmes of CEng Further Learning (FL) (Technical' & 'Non-technical' MScs and FL Programmes)

Introduction

1. There are three pathways to becoming a Chartered Engineer by following an MSc programme:-

   a) Graduates with an UK accredited BEng (Hons) that is recognised as part of the educational base to become a Chartered Engineer and complete an accredited technical or non-technical MSc programme.
   b) Graduates with a degree that is accredited as the educational base for an IEng (e.g. BSc) or someone who has completed the educational base to become an Incorporated Engineer (IEng) (e.g. FD + FL) will need to apply for an academic assessment by their chosen professional institution and complete a "Technical" MSc programme.
   c) Graduates with a degree in civil (or structural or transport) engineering which is not accredited or graduates with cognate degrees who complete an MSc programme in engineering will need to submit their package of qualifications (Bachelors and Masters) for assessment by their chosen professional institution. Such candidates may need some additional Further Learning. This pathway reflects the fact that many accredited MSc programmes can be followed by overseas and non-engineering graduates.

2. This document provides guidelines that can be used to distinguish between those MSc programmes designed to provide further learning for those engineers who have completed the educational base to become an Incorporated Engineer (e.g. graduates with an accredited BSc degree) and those designed for graduates with a CEng accredited bachelor degree. They are based on the QAA Subject Benchmark Statement (Engineering) (2015), which will be referred to as QAA (engineering).

3. QAA (engineering) uses the view of the engineering profession to distinguish between a CEng and an IEng. Both use creativity and innovation and are involved in activities such as design, production, construction, operation and disposal. Both are likely to be involved in commercial and technical management. CEngs are more likely to be involved in the development and application of new technologies, concepts, techniques and services, while IEngs will be concerned with the application and management of current technology. Master's programmes should also provide an opportunity to integrate the technical and non-technical aspects of engineering and to develop a commitment to professional and social responsibility and ethical codes of conduct.

4. QAA (engineering) state that the CEng accredited bachelor degree plus further learning or an integrated MEng provide the educational base for a Chartered Engineer. It is not clear that QAA (engineering) assume that it is possible to move from an IEng accredited qualification to become a Chartered Engineer through further learning but given the need to provide flexible routes to chartership the JBM is of the opinion that such a route is possible.

5. There is also a distinction between the teaching and learning within an MEng programme and a BEng Hons programme. The MEng programme includes a deepening of technical understanding, additional emphasis on team/group working, an increase in use of industrially relevant applications of engineering analysis and an enhanced capability for independent learning and work. Thus Masters level graduates are expected to demonstrate greater capacities for

independent action, accepting responsibilities, formulating ideas proactively, dealing with open ended and unfamiliar problems, planning and developing strategies, implanting and executing agreed plans, leading and managing teams, evaluating achievement against specification and plan, and decision making.

6. QAA (engineering) state that the UK-SPEC output standards are the subject benchmark statements for engineering. The learning outcomes for Masters degrees other than the Integrated Masters (MEng) over and above those for the BEng graduate* provide a useful guide for an MSc programme that is designed as further learning for a BEng graduate. These can be found in the EngC document "Accreditation of HE Programmes (AHEP): Collated learning outcomes for six areas of learning" (2014). Since the further learning for an IEng graduate** is designed to achieve the educational base for a Chartered Engineer the learning outcomes for an MSc designed for such a graduate must at least conform to that for a BEng graduate. But the entry standards will be different which implies that there has to be additional learning outcomes for an MSc for further learning for an IEng graduate to ensure that IEng graduates can achieve the correct exit standard. This implies that IEng graduates will be expected to achieve more in the MSc programme than the BEng graduates. This is not feasible given the typical period over which an MSc takes place. Therefore the MSc for an IEng graduate must differ from that for a BEng graduate and the distinguishing features outlined above have to be taken into account. Thus an MSc for an IEng graduate must cover the development and application of new technologies, concepts, techniques and services; that is the MSc for an IEng graduate has to be concerned with technical deepening and a greater focus on analysis and has to be accredited as a 'Technical' MSc.

7. This document provides guidance on the Learning Outcome (LO) requirements of both 'Technical' and 'Non-technical' MScs.

8. A 'Technical' MSc programme is one in which at least 50% of the taught modules AND the dissertation are of a technical nature. The academic credits usually provide the basis for assessing the percentage. The definition of 'Technical' covers the JBM List A subjects (i.e. structures, materials, geotechnics) as well as fluid mechanics and water engineering, surveying, infrastructure and transportation engineering, public health and environmental engineering and must additionally address the learning outcomes in Table 1, which are those that distinguish a BEng (Hons) graduate from an IEng graduate.

9. As a consequence of the above a majority of the topics studied in a 'Technical' MSc must require the individual to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems and to apply and integrate knowledge and understanding of other engineering disciplines to support the study of their own engineering discipline. They should require the student to demonstrate a sound understanding of engineering principles and an ability to apply them to analyse key engineering processes. They should include opportunities to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques and to apply an integrated or systems approach to solving engineering problems. There must be investigative projects that require the individual apply advanced problem-solving skills, technical knowledge and understanding, to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem and opportunities to demonstrate an ability to apply relevant practical and laboratory skills and to work with technical uncertainty.

10. A 'Technical' dissertation is similarly likely to be in one of the above technical subjects, to demonstrate a sound understanding of engineering principles and an ability to apply them to analyse key engineering problems. It should involve the use of analytical methods and modelling techniques, and to have required the definition and investigation of a problem including

consideration of aspects of the wider engineering context such as environmental and sustainability implications; ethical, health, safety, security and risk issues; intellectual property; and legal, contractual, quality and cost issues. The assessment of the dissertation should have required the individual to demonstrate an ability to plan, manage and evaluate the outcomes of their work and an ability to communicate it to both technical and non-technical audiences.

'Technical' or 'Non-Technical' required?

11. Engineers with a BEng (Hons)* that is accredited by their Institution as partially meeting the educational requirements for CEng may select either type of MSc to complete their educational requirements for CEng. Engineers with other bachelor level qualifications that are accepted by their Institution for CEng, on an individual case basis, may also do so.

12. Engineers with other bachelor level qualifications or equivalent that are acceptable to their Institution for IEng registration** require a 'Technical' MSc.

Content of 'Technical' and 'Non-technical' MScs and FL Programmes

13. The requirements of Technical and 'Non-technical' MScs in relation to the coverage of Engineering Council learning output standards are given in Tables 2 and 3.

The Categories of LOs referred to in this document have been defined by the JBM:

Category 1 LO: there must be evidence to show that this LO has been achieved.
Category 2 LO: it is preferred that there should be evidence to show that this LO has been achieved. However, inclusion of all Category 2 LOs is not essential, subject to the minimum requirements given in Table 2.

14. Evidence must be available that all LOs included in an MSc or programme of further learning have been assessed and achieved.

15. It is encouraged that teaching/learning on MScs and FLPs should encompass all 22 of the LOs in Table 3, noting that the requirements given in Table 1 relate to the minimum for which there must be both learning and evidence of assessment of that learning.

* A graduate possessing an accredited bachelor's degree that partially satisfies the educational base for CEng.

** A graduate possessing an accredited degree that fully satisfies the educational base for IEng.

QAA (engineering): UK Quality Code for Higher Education. Part A: Setting and marinating academic Standards, Subject Benchmark Statement, Engineering, February 2015.
www.qaa.ac.uk/en/Publications/Documents/SBS-engineering-15.pdf

Accreditation of HE Programmes (AHEP): Collated learning outcomes for six areas of learning (2014)
https://www.engc.org.uk/engcdocuments/internet/website/Accreditation%20of%20Higher%20Education%20Programmes%20third%20edition%20collated%20learning%20outcomes%20(1).pdf

Table 1: Learning Outcomes that distinguish a BEng (Hons) graduate from an IEng graduate

	Science and mathematics
i	Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems
ii	Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.
	Engineering Analysis
iii	Understanding of engineering principles and the ability to apply them to analyse key engineering processes
iv	Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques
v	Understanding of, and the ability to apply, an integrated or systems approach to solving engineering problems.
	Design
vi	Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics
vii	Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards
viii	Apply advanced problem-solving skills, technical knowledge and understanding, to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem including production, operation, maintenance and disposal
ix	Plan and manage the design process, including cost drivers, and evaluate outcomes

	Engineering practice
x	Ability to apply relevant practical and laboratory skills
xi	Understanding of the use of technical literature and other information sources
xii	Knowledge of relevant legal and contractual issues
xiii	Understanding of appropriate codes of practice and industry standards
xiv	Ability to work with technical uncertainty

Notes:

1. Broad areas of learning and learning outcomes (LOs) are taken from The Accreditation of Higher Education Programmes, Engineering Council (2014), 3rd Ed

Table 2: Minimum number of Learning Outcomes (LOs) by Broad Area of Learning

Broad area of learning (Note 1)	**Number of LOs in each broad area of learning**	**Minimum number of LOs to be included in MSc/FL Prog'**	
		'Technical' MSc	**'Non-technical' MSc**
Science and mathematics	3	2	1
Engineering analysis	3	2	1
Design	3	2	1
Economic, legal, social, ethical and environmental context	6	3	3
Engineering practice	4	3	3
Additional general skills	3	2	2
Additional LOs, selected from the 6 broad areas of learning (max 2 from any one area)		Minimum 2	Minimum 5
Minimum overall total LOs:		16	16

Table 3: Learning Outcomes for MScs and FL Programmes, with JBM Categories of LO for 'Technical' and 'Non-technical'

See Table 1 for <u>minimum</u> number of LOs in each broad area of learning					
LO No.	**Tech**		**Non-tech**		
	Category		**Category**		**Learning Outcome (LO)**
	1	**2**	**1**	**2**	
	Science and mathematics				
i		✓		✓	A comprehensive understanding of the relevant scientific principles of the specialisation;
ii	✓			✓	A critical awareness of current problems and/or new insights much of which is at, or informed by, the forefront of the specialisation;
iii		✓		✓	Understanding of concepts relevant to the discipline, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in engineering projects.
	Engineering Analysis				
iv		✓		✓	Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations
v		✓		✓	The ability to use fundamental knowledge to investigate new and emerging technologies;
vi		✓		✓	The ability to collect and analyse research data and use appropriate engineering tools to tackle unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods.

LO	T 1	T 2	NT 1	NT 2	Learning Outcome (LO)
	Design				
vii		✓		✓	Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies
viii		✓		✓	Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations
ix		✓		✓	Ability to generate an innovative design for products, systems, components or processes to fulfil new needs.
	Economic, legal, social, ethical and environmental context				
x		✓		✓	Awareness of the need for a high level of professional and ethical conduct in engineering
xi		✓		✓	Awareness that engineers need to take account of the commercial and social contexts in which they operate
xii		✓		✓	Knowledge and understanding of management and business practices, and their limitations, and how these may be applied in the context of the particular specialisation;
xiii	✓		✓		Awareness that engineering activities should promote sustainable development and ability to apply quantitative techniques where appropriate
xiv		✓		✓	Awareness of relevant regulatory requirements governing engineering activities in the context of the particular specialisation
xv	✓		✓		Awareness of and ability to make general evaluations of risk issues in the context of the particular specialisation, including health & safety, environmental and commercial risk.

LO	T 1	T 2	NT 1	NT 2	Learning Outcome (LO)
	Engineering practice				
xvi	✓			✓	Advanced level knowledge and understanding of a wide range of engineering materials and components;
xvii	✓			✓	A thorough understanding of current practice and its limitations, and some appreciation of likely new developments;
xviii		✓		✓	The ability to apply engineering techniques taking account of a range of commercial and industrial constraints.
xix		✓		✓	Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader;
	Additional general skills				
xx		✓		✓	Apply their skills in problem solving, communication, information retrieval, working with others, and the effective use of general IT facilities
xxi	✓		✓		Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
xxii		✓		✓	Monitor and adjust a personal programme of work on an on-going basis
~~xxiii~~					*(excluded - covered by LO xix)* Exercise initiative and personal responsibility, which may be as a team member or leader.
Notes:					
2. Broad areas of learning and learning outcomes (LOs) are taken from *The Accreditation of Higher Education Programmes*, Engineering Council (2014), 3rd Ed					