APPENDIX A
BACHELORS AND INTEGRATED MASTERS DEGREE LEARNING OUTCOMES.

Institution of MECHANICAL ENGINEERS

Output Standards for Accredited Programmes based on The Accreditation of Higher Education Programmes (AHEP) 3rd Edition

For all degrees the weighting given to the six broad areas of learning below will vary according to the nature of the aims of each programme.

Bachelors degrees and Bachelors (Honours) degrees accredited for the purpose of IEng registration will have an emphasis on development and attainment of the know-how necessary to apply technology to engineering problems and processes, and to maintain and manage current technology, sometimes within a multidisciplinary engineering environment. Graduates from accredited Bachelors or Bachelors (Honours) degree programmes must achieve the learning outcomes described below. The breadth and depth of underpinning scientific and mathematical knowledge, understanding and skills will be provided in the most appropriate manner to enable the application of engineering principles within existing technology to future engineering problems and processes. Graduates are likely to have acquired some of this ability through involvement in individual and/or group design projects.

Programmes will develop a knowledge and understanding of current engineering practice and processes, with less focus on analysis than in programmes accredited for CEng. Design will be a significant component, especially in integrating a range of knowledge and understanding to design products, systems and processes to meet defined needs using current technology.

Bachelors (Honours) degrees accredited as partially meeting the educational requirement for CEng develop the ability to apply a thorough understanding of relevant science and mathematics to the analysis and design of technical solutions to improve quality of life. Graduates from accredited Bachelors (Honours) programmes must achieve a systematic understanding of the learning outcomes described below, including acquisition of coherent and detailed knowledge, much of which is at, or informed by, the forefront of defined aspects of the relevant engineering discipline. Crucially, they will have the ability to integrate their knowledge and understanding of mathematics; science; computer-based methods; design; the economic, legal, social, ethical and environmental context; and engineering practice to solve problems, some of a complex nature, in their chosen engineering discipline. They are likely to have acquired some of this ability through involvement in individual and/or group design projects.

Integrated Masters (MEng) degrees accredited for CEng registration include the outcomes of accredited Bachelors (Honours) degrees and go beyond to provide a greater range and depth of specialist knowledge, within a research and industrial environment, as well as a broader and more general academic base. Such programmes should provide both a foundation for leadership and a wider appreciation of the economic, legal, social, ethical and environmental context of engineering.

Graduates from an accredited integrated Masters (MEng) degree must achieve a systematic understanding of the learning outcomes described below, including acquisition of coherent and detailed knowledge, most of which is at, or informed by, the forefront of defined aspects of the relevant engineering discipline. Some of the

learning outcomes will be to levels deeper and broader than in a Bachelors programme, the balance of which will vary according to the nature and aims of each programme. Crucially, graduates will have the ability to integrate their knowledge and understanding of mathematics; science; computer-based methods; design; the economic, legal, social, ethical and environmental context; and engineering practice to solve a substantial range of engineering problems, some of them complex or novel. They will have acquired much of this ability through involvement in individual and group design projects. Ideally some of these projects would have industrial involvement or be practice-based.

Learning outcomes specified in AHEP for Bachelors degree and Bachelors (Honours) degrees accredited for IEng registration, Bachelors (Honours) degrees accredited as partially meeting the academic requirement for CEng registration (with further learning to Masters level required), and Integrated Masters (MEng) degrees accredited in full for CEng registration.

INTERPRETATION

In the tables below the following terms are used with the meanings stated:

Understanding is the capacity to use concepts creatively, for example, in problem solving, design, explanations and diagnosis.	**Knowledge** is information that can be recalled.	**Know-how** is the ability to apply learned knowledge and skills to perform operations intuitively, efficiently and correctly.
Skills are acquired and learned attributes that can be applied almost automatically.	**Awareness** is general familiarity, albeit bounded by the needs of the specific discipline.	**Complex** implies engineering problems, artefacts or systems that involve dealing simultaneously with a sizeable number of factors that interact and require deep understanding, including knowledge at the forefront of the discipline, to analyse or deal with.

In the tables below, learning outcomes related specifically to Bachelors and Bachelors (Honours) degree accredited for IEng are numbered with an 'i'; learning outcomes related specifically to Bachelors (Honours) degrees accredited for CEng (with further learning required) are numbered with a 'b'; learning outcomes related specifically to Integrated Masters degrees accredited for CEng are numbered with an 'm'. Where a learning outcome applies to IEng or CEng and is identical to the statement for Bachelors (Honours) for CEng, it is shown in the relevant column(s) with no 'i', 'b' or 'm'. Note the number is only for the purpose of enabling a matrix for IMechE submissions.

SCIENCE AND MATHEMATICS (SM)

Engineering is underpinned by science and mathematics, and other associated disciplines. Graduates will need:

Bachelors and Bachelors (Honours) degrees accredited for IEng		Bachelors (Honours) degrees accredited for CEng (with further learning required)		Integrated Masters (MEng) degrees accredited for CEng	
SM1i	Knowledge and understanding of the scientific principles underpinning relevant technologies, and their evolution	**SM1b**	Knowledge and understanding of scientific principles and methodology necessary to underpin their education in mechanical and related engineering disciplines, to enable appreciation of its scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies	**SM1m**	A comprehensive knowledge and understanding of the scientific principles and methodology necessary to underpin their education in mechanical and related engineering disciplines, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies
SM2i	Knowledge and understanding of mathematics and an awareness of statistical methods necessary to support application of key engineering principles	**SM2b**	Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in mechanical and related engineering disciplines and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems	**SM2m**	Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in mechanical and related engineering disciplines, and to enable them to apply a range of mathematical and statistical methods, tools and notations proficiently and critically in the analysis and solution of engineering problems

		SM3b	Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of mechanical and related engineering disciplines	**SM3m**	Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of mechanical and related engineering disciplines and the ability to evaluate them critically and to apply them effectively
				SM4m	Awareness of developing technologies related to mechanical engineering.
				SM5m	A comprehensive knowledge and understanding of mathematical and computational models relevant to mechanical engineering, and an appreciation of their limitations
				SM6m	Understanding of concepts from a range of areas, including some outside engineering, and the ability to evaluate them critically and to apply them in engineering projects

ENGINEERING ANALYSIS (EA)

Engineering analysis involves the application of engineering concepts and tools to the solutions of engineering problems. Graduates will need:

Bachelors and Bachelors (Honours) degrees accredited for IEng		Bachelors (Honours) degrees accredited for CEng (with further learning required)		Integrated Masters (MEng) degrees accredited for CEng	
EA1i	Ability to monitor, interpret and apply the results of analysis and modelling in order to bring about continuous improvement	**EA1b**	Understanding of engineering principles and the ability to apply them to analyse key engineering processes	**EA1m**	Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes
EA2i	Ability to apply quantitative methods in order to understand the performance of systems and components	**EA2**	Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques	**EA2**	Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques
EA3i	Ability to use the results of engineering analysis to solve engineering problems, and to recommend appropriate action	**EA3b**	Ability to apply quantitative and computational methods in order to solve engineering problems and to implement appropriate action	**EA3m**	Ability to apply quantitative and computational methods, using alternative approaches, and understanding their limitations, in order to solve engineering problems and implement action
EA4i	Ability to apply an integrated or systems approach to engineering problems through know-how of the relevant technologies and their application	**EA4b**	Understanding of, and the ability to apply, an integrated systems approach to solving engineering problems	**EA4m**	Understanding of, and the ability to apply, an integrated or systems approach to solving complex engineering problems
				EA5m	Ability to use fundamental knowledge to investigate new and emerging technologies
				EA6m	Ability to extract and evaluate pertinent data and to apply engineering analysis techniques in the solution of unfamiliar problems

DESIGN (D)

Design at this level is the creation and development of an economically viable product, process or system to meet a defined need. It involves significant technical and intellectual challenges and can be used to integrate all engineering understanding, knowledge and skills to the solution of real problems. Graduates need the knowledge, understanding and skills to:

Bachelors and Bachelors (Honours) degrees accredited for IEng		**Bachelors (Honours) degrees accredited for CEng (with further learning required)**		**Integrated Masters (MEng) degrees accredited for CEng**	
D1i	Be aware of business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics	**D1**	Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics	**D1**	Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics
D2i	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	**D2**	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	**D2**	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
D3i	Work with information that may be incomplete or uncertain and be aware that this may affect the design	**D3b**	Work with information that may be incomplete or uncertain and quantify the effect of this on the design	**D3m**	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
D4i	Apply problem-solving skills, technical knowledge and understanding to create or adapt design solutions that are fit for purpose including operation, maintenance, reliability, etc.	**D4**	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	**D4**	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

D5i	Manage the design process, including cost drivers, and evaluate outcomes	**D5**	Plan and manage the design process, including cost drivers, and evaluate outcomes	**D5**	Plan and manage the design process, including cost drivers, and evaluate outcomes
D6	Communicate their work to technical and non-technical audiences	**D6**	Communicate their work to technical and non-technical audiences	**D6**	Communicate their work to technical and non-technical audiences
				D7m	Demonstrate wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations
				D8m	Demonstrate the ability to generate an innovative design for products, systems, components or processes to fulfil new needs

ECONOMIC, LEGAL, SOCIAL, ETHICAL AND ENVIRONMENTAL CONTEXT (EL)

Engineering activity can have impact on the environment, on commerce, on society and on individuals. Graduates therefore need the skills to manage their activities and to be aware of the various legal and ethical constraints under which they are expected to operate, including:

Bachelors and Bachelors (Honours) degrees accredited for IEng		**Bachelors (Honours) degrees accredited for CEng (with further learning required)**		**Integrated Masters (MEng) degrees accredited for CEng**	
EL1	Understanding of the need for a high level of professional and ethical conduct in engineering and a knowledge of professional codes of conduct	**EL1**	Understanding of the need for a high level of professional and ethical conduct in engineering and a knowledge of professional codes of conduct	**EL1m**	Understanding of the need for a high level of professional and ethical production in engineering, a knowledge of professional codes of conduct, and how ethical dilemmas can arise
EL2	Knowledge and understanding of the commercial, economic and social context of engineering processes	**EL2**	Knowledge and understanding of the commercial, economic and social context of engineering processes	**EL2**	Knowledge and understanding of the commercial, economic and social context of engineering processes
EL3i	Knowledge of management techniques that may be used to achieve engineering objectives	**EL3b**	Knowledge and understanding of management techniques, including project management, that may be used to achieve engineering objectives	**EL3m**	Knowledge and understanding of management techniques, including project and change management, that may be used to achieve engineering objectives, their limitations, and how they may be applied appropriately
EL4i	Understanding of the requirement for engineering activities to promote sustainable development	**EL4**	Understanding of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate	**EL4**	Understanding of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate

EL5	Awareness of the relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues	**EL5**	Awareness of the relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues	**EL5m**	Awareness of the relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues, and an awareness that these may differ internationally
EL6i	Awareness of risk issues, including health & safety, environmental and commercial risk	**EL6b**	Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk, and of risk assessment and risk management techniques	**EL6m**	Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk, risk assessment and risk management techniques, and an ability to evaluate commercial risk
				EL7m	Understanding of the key drivers for business success, including innovation, calculated commercial risks and customer satisfaction

ENGINEERING PRACTICE (P)

This is the practical application of engineering skill, combining theory and experience, and use of other relevant knowledge and skills. This can include:					
Bachelors and Bachelors (Honours) degrees accredited for IEng		**Bachelors (Honours) degrees accredited for CEng (with further learning required)**		**Integrated Masters (MEng) degrees accredited for CEng**	
P1i	Knowledge of contexts in which engineering knowledge can be applied (e.g. operations and management, application and development of technology, etc.)	**P1**	Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, application and development of technology, etc.)	**P1**	Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, application and development of technology, etc.)
P2i	Understanding of and ability to use relevant materials, equipment, tools, processes, or products	**P2**	Knowledge of characteristics of particular materials, equipment, processes or products	**P2m**	Knowledge of characteristics of particular materials, equipment, processes or products, with extensive knowledge and understanding of a wide range of engineering materials and components
P3i	Knowledge and understanding of workshop and laboratory practice	**P3**	Ability to apply relevant practical and laboratory skills	**P3**	Ability to apply relevant practical and laboratory skills
P4i	Ability to use and apply information from technical literature	**P4**	Understanding use of technical literature and other information sources	**P4**	Understanding use of technical literature and other information sources
		P5	Knowledge of relevant legal and contractual issues	**P5**	Knowledge of relevant legal and contractual issues
P6i	Ability to use appropriate codes of practice and industry standards	**P6**	Understanding of appropriate codes of practice and industry standards	**P6**	Understanding of appropriate codes of practice and industry standards
P7	Awareness of quality issues and their application to continuous improvement	**P7**	Awareness of quality issues and their application to continuous improvement	**P7**	Awareness of quality issues and their application to continuous improvement
		P8	Ability to work with technical uncertainty	**P8**	Ability to work with technical uncertainty
				P9m	A thorough understanding of current practice and its limitations, and some

					appreciation of likely new developments
				P10m	Ability to apply engineering techniques taking account of a range of commercial and industrial constraints
P11i	Awareness of team roles and the ability to work as a member of an engineering team	**P11b**	Understanding of, and the ability to work in, different roles within an engineering team	**P11m**	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 (G)

Graduates must have developed transferable skills, additional to those set out in the other outcomes, that will be of value in a wide range of situations, including the ability to:

Bachelors and Bachelors (Honours) degrees accredited for IEng		Bachelors (Honours) degrees accredited for CEng (with further learning required)		Integrated Masters (MEng) degrees accredited for CEng	
G1	Apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities	**G1**	Apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities	**G1**	Apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities
G2	Plan self-learning and improve performance, as the foundation for lifelong learning/CPD	**G2**	Plan self-learning and improve performance, as the foundation for lifelong learning/CPD	**G2**	Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
G3i	Plan and carry out a personal programmes of work	**G3b**	Plan and carry out a personal programmes of work, adjusting where appropriate	**G3m**	Monitor and adjust a personal programme of work on an on-going basis
G4i	Exercise personal responsibility, which may be as a team member	**G4**	Exercise initiative and personal responsibility, which may be as a team member or leader	**G4**	Exercise initiative and personal responsibility, which may be as a team member or leader

Other reference points are:

- QAA's Framework for HE Qualifications in England, Wales and Northern Ireland: **http://www.qaa.ac.uk/assuring-standards-and-quality/the-quality-code/qualifications**
- The Scottish Credit and Qualifications Framework: **www.scqf.org.uk**