

Joint Board of Moderators 2017

Guidelines for Developing Degree Programmes:

- MEng programmes leading to Chartered Engineer
- BEng (Hons) programmes as a route towards Chartered Engineer
- Bachelor's degree programmes leading to Incorporated Engineer

This document provides guidance for higher education institutions (*HEIs) which are developing degree programmes and seeking JBM accreditation.

For information about developing MSc (for further learning) programmes, refer to [JBM Guidelines for MScs and Programmes of CEng Further Learning \(FL\) \(Technical and Non-technical MScs and FL Programmes\) \(FLJBM9\)](#)

*For the purpose of this document, the term HEI includes all levels of education provider.

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Introduction

These guidelines are for higher education institutions (HEIs), or other educational establishments, which are seeking to develop degree programmes for accreditation by the Joint Board of Moderators.

The Joint Board of Moderators (JBM) was established by the Institution of Civil Engineers (ICE), the Institution of Structural Engineers (IStructE), the Institute of Highway Engineers (IHE), and the Chartered Institution of Highways and Transportation (CIHE) to coordinate accreditation activities for educational programmes in the civil, structural, transportation and associated engineering disciplines within the built engineering sector.

The Engineering Council (EngC) sets the overall requirements for the Accreditation of Higher Education Programmes (AHEP) in engineering, in line with the [UK Standard for Professional Engineering Competence \(UK-SPEC\)](#). The JBM is licensed by the EngC to accredit engineering degree programmes that partially or fully satisfy the academic requirements for Incorporated Engineer (IEng) or Chartered Engineer (CEng).

In addition to complying with the UK-SPEC's outcomes-based approach, the JBM has a number of civil engineering-specific requirements which must be met, and these are set out within these guidelines.

The JBM wants to avoid over-prescription and recognises that HEIs must be encouraged to develop programmes in ways that make the best use of their strengths and provide students with stimulating and relevant education experiences. But, while degree programmes providing the early career education-base for student engineers may vary in style and content, all should encompass the common and fundamental knowledge and skills described within these guidelines (see Part Two) which provide the benchmark for degree accreditation.

The guidelines have been divided into two parts:

Part One (Annexes A-I) sets out the achievement levels required for entry onto degree programmes, and provides detailed guidance concerning the 'threads' of design; sustainability; health and safety risk management; and professionalism and ethics – all of which are required by the JBM to be fully integrated within engineering teaching and learning – as well as information on industrial placements and site visits, and the teaching of surveying.

Part Two identifies the specific programme objectives, characteristics and academic requirements for HEIs seeking JBM accreditation of degree programmes.



Part One: Annexes A-I

This section of the guidelines sets out the achievement levels required for entry onto degree programmes and provides guidance concerning the threads of design; sustainability; health and safety risk management; and professionalism and ethics – all of which are required by the JBM to be fully integrated within engineering teaching and learning – as well as information on industrial placements and site visits, and the teaching of surveying.

A number of learning and skills outcomes have been included within the annexes. These are in line with AHEP standards but are for guidance only; HEIs must decide how they develop their own programmes to meet the JBM's requirements.

The annexes were last issued in 2009 and readers should note the following updates to the threads:

- An increased emphasis on practical, applied and authentic design exercises, not merely of design procedures but the design process as a whole, as a means to consolidate learning
- A focus on the importance of providing a learning environment which facilitates collaboration, creative thinking and ingenuity
- An emphasis on the development of a multi-faceted approach which seeks to integrate and incorporate the key threads of design, sustainability, and health and safety risk management (as well as creativity) throughout engineering and construction (as detailed in the annexes which appear below)
- The incorporation of professionalism and ethics, with the expectation that engineering graduates should uphold professional responsibility, maintain an ethical perspective and appreciate the need for continuing professional development
- The requirement to develop freehand sketching as a standard tool of engineering. Sketching is needed for design (from simple line diagrams to detailed plans), surveying, communication, and as a means to convey an aesthetic sensibility that is informed by a depth of engineering understanding



ANNEX A: ACHIEVEMENT LEVELS FOR ENTRY ONTO DEGREE PROGRAMMES

Introduction

The following levels of achievement for entry onto degree programmes have, over a long period, been found to be consistent with the attainment of appropriate standards at graduation. While not mandatory requirements, where there are any significant deviations from these standards, the JBM expects to see sound evidence as to what special measures have been taken to make sure that the students concerned will be able to reach an appropriate standard.

Achievement level for entry onto accredited MEng/BEng (Hons) degree programmes

The UCAS tariff point expectations outlined below are to be calculated on the basis of achievements in three A-levels (or equivalent), where an aggregate of 168 UCAS tariff points is the maximum attainable.

MEng The expectation is a minimum of 120 UCAS tariff points.

BEng (Hons) The expectation is a minimum of 88 UCAS tariff points.

MEng/BEng (Hons) For programmes which have an initial joint-intake policy, the minimum entry requirement may be set at the BEng (Hons) threshold (88 UCAS tariff points), but a substantial majority of students eventually going on to the MEng programme should satisfy the expected minimum MEng entry threshold (120 UCAS tariff points). If this suggested minimum threshold level is not achieved on particular programmes, then the JBM will wish to be assured that special measures have been put in place to ensure that MEng learning outcomes can be safeguarded for such cohorts.

Mathematics A-level, or its equivalent, is normally a requirement for entry onto an MEng/BEng (Hons) programme. Where students do not have A-level mathematics, the JBM will wish to know how the cohort entry extremes have been supported.

Entry from foundation courses, or other comparable qualifications, is appropriate only if a substantial majority of the student cohort meets the expected entry requirements (as indicated above). The JBM will require evidence that performance of such candidates is equivalent to those entering with the expected entry requirements.

Achievement level for entry onto accredited bachelor degree programmes leading to Incorporated Engineer

BSc (and other accredited degree programmes for IEng) The expectation is a minimum of 48 UCAS tariff points.

A pass from a foundation programme would meet the entry requirements for an IEng degree (a 40% pass mark is equivalent to 48 UCAS tariff points). The JBM will require evidence that the performance of such candidates is equivalent to those entering with A-levels.

ANNEX B: DESIGN IN DEGREE PROGRAMMES

Introduction

Design describes a process of imagination and creativity that applies to all engineering activities, whether the requirement is to produce an artefact, a process, or a conceptual framework. The JBM views design as a core engineering activity which must be fully integrated within teaching and learning throughout the engineering education programme.

The interpretation and execution of design may be carried out by an individual engineer but is typically a collaborative activity where individuals contribute a range of interests, knowledge and skills. Creativity requires imagination, intuition, intellectual rigour, and the sound application of underlying engineering principles, all of which impact upon decision-making. Design can be part of the engineer's role when developing new products, markets or strategic ideas, or when seeking to interpret and construct others' concepts on site. Whatever the requirement, the engineer must demonstrate good judgement, ingenuity, an ability to adapt and modify proposals, and generally display imagination and flair.

The environment in which design projects are undertaken is extremely important. The design office is the designer's equivalent of the building site and, as such, should contain the materials, tools, information and other resources for student design teams to perform safely and effectively. HEIs should endeavour to provide an environment and resources for students to undertake design work that reflects the best to be found in engineering practice. The design office should have facilities which encourage and enable students to draw, make physical and digital models and run simulations. This should facilitate the development of useful freehand sketching as a standard tool of engineering conversation and also as a way to convey a concept or an idea that is informed by a depth of engineering understanding. Conveying the idea of a three-dimensional concept may be too intractable, even for sketching, and so it would be appropriate for students to gain experience of model-making, which could also be a useful tool for learning construction techniques and for practical constructability considerations.

Although the above suggests a sequential pattern of steps, from conception to production, it is rare that the art of design can be performed in such a linear way; there is almost always a need to 'backtrack' and reconsider. It is said that design can be thought of as a highly iterative process, involving necessary compromises between conflicting needs, but also much hard work, self-criticism and discussion in which both visual and engineering understanding need to be combined from start to finish of the design process.

Aims

The aim of the undergraduate-level design thread is to provide students with the skills and opportunities to devise safe, economical and creative solutions which demonstrate a student's design competency and developing practical engineering skills.

The art of engineering design is probably best explored by examining some of the activities the design engineer is involved in. The following are indicative (not exhaustive) of some of the more important design attributes of a competent engineer:

Knowledge and understanding

Students will possess the knowledge and understanding to enable them to:

- Be aware that design is a creative process in which experience and a thorough knowledge of historical precedent can inform both conscious choice and intuition and
- Gather, assimilate and apply relevant knowledge and information to environmental and planning issues (including site conditions, material suppliers, collaborators, specialists and other contractors) to inform the design process at the point of need
- Demonstrate how the construction method, issues of safety and legislation, and the concepts of buildability can strongly influence design choices
- Be aware of how the economy, sustainability, ethics, politics and the impact on society can affect design

- Identify and assess risks throughout the design process, and decide on methods of elimination and/or control

Intellectual ability

Students will be able to:

- Appreciate the importance of the study of engineering history, the forces that have shaped that history and how engineering developments have affected our material culture
- Appreciate the relationships between art history, architecture and engineering, as part of the development of greater visual awareness.
- Appreciate, through the study of past failures, the causes of engineering failure and the need to 'think failure to avoid it'
- Contextualise their theoretical studies
- Provide a context in which the principles of engineering science, and other taught material, may be applied in the creative design process
- Manage the uncertainties associated with a complex design brief and, where there are several viable solutions, to explain and defend the chosen outcome
- 'Think outside the box' in order to find better solutions, for example by renegotiating the brief to explore promising search space beyond unnecessarily imposed constraints (explicit or implicit)
- Sort, synthesise and perhaps challenge all information so that proposed solutions can be tested against the criteria identified in the brief and the overall functional, social and economic objectives
- Justify the chosen solution (including in a non-technical language) to stakeholders
- Demonstrate an increasing awareness, and development of, the skills for planning, tracking and evaluating the processes in design

Practical skills

Students will be able to:

- Demonstrate, through design work, projects, coursework and/or examinations, a strong awareness of, and commitment to, the principles of sustainable development, as outlined in Annex C
- Identify an appropriate range of construction technologies for the project they are working on
- Plan and track progress, both at the sub-component levels of the design and in the overall design process, while working towards a solution
- Demonstrate clear communication skills through their sketching, drawing and modelling
- Interact with stakeholders to help the client and other team members (including those from other professions) to develop a better understanding of the brief, including the functional, social and economic objectives

General transferable skills

Students will be able to:

- Demonstrate team working skills
- Demonstrate creative skills through design projects and other activities
- Communicate clearly and knowledgeably about design issues, especially to those with a non-technical background

Learning and assessment methods

HEIs should provide a stimulating environment to facilitate students' creative, clear and logical thinking and to encourage an interest and appreciation of engineering as an intellectual and professional activity. Students should be encouraged, with appropriate support and guidance made available, to take responsibility for their own learning and intellectual development.

Engineering design requires in-depth analysis (which is broader than 'mathematical analysis'), synthesis, imagination and creativity to be embedded throughout the process, from conception to production. It is vital, therefore, that, during the early stage of their engineering education, students gain in-depth experience of those activities that are central to the design process. Students learn design best by having the opportunity to practise, albeit within the restrictions of an education environment; to utilise case studies; undergo reflective learning; and other techniques as appropriate.

In practice, design is almost always a team activity and as such students should work in groups for a substantial part of their design learning experience. Creativity is an intellectual process involving the generation of new ideas and concepts or the development of new associations between existing ideas or concepts. Real engineering projects are unique and, for this reason, their design requires creativity; it is important that students develop their creative skills through design projects and other activities within their studies. Design projects provide a natural place for students to demonstrate their knowledge and practise their skills in relation to sustainability and health and safety. The JBM therefore recommends that Annexes B, C and D are considered together, especially in relation to teaching and learning methodology and assessment.

It is recognised that high-level design skills and experience are often hard to find in HEIs and they are encouraged to involve practising engineers in the development and delivery of design teaching. Typically, this can be achieved through the provision of advice at the stage of setting projects and the partial supervision of group design projects. In addition, any connections to clients and contractors are beneficial.

Students will undertake a variety of design tasks over the course of their studies which should include:

- The design of hydraulic systems, highways schemes or structural elements where, typically, the brief is simple; the options are few and obvious; the tests are technically very challenging and numerical in character; and the judgements are objective
- 'Realistic projects' (both large and small) such as railways, airports, hydropower schemes, bridges, skyscrapers, water treatment works, highways or similar. Such projects are characterised by: extremely complex briefs which are full of diverse and often contradictory aspirations; numerous and often obscure constraints; unexplored opportunities relating to the site and the socio-economic context; typically incomplete information; and only approximate data



ANNEX C: SUSTAINABILITY IN DEGREE PROGRAMMES

Introduction

The JBM requires that sustainable development be integrated into existing teaching and learning, and should clearly feature throughout the education programme.

Increasingly, governments and the public are demanding sustainable development and engineers should be able to respond to societies' concerns about the impact of human activity on the environment while seeking to attain a balance between environmental, social and economic outcomes.

Aims

Students will become attuned to the need to design and engineer projects which manage our impact on the environment, and which enhance humankind's endeavours in a sustainable manner.

Knowledge and understanding

Students will possess the knowledge and understanding to enable them to:

- Be aware of the implications of climate change, international protocols associated with climate change, and the low-carbon agenda and how these impact on engineering design, construction and operation
- Take account of the context of environmental, economic, political, interdisciplinary, global and social issues and other dimensions, including ethics and environmental justice, when dealing with engineering problems
- Be aware of the use of environmental management systems, environmental impact assessment, and social impact assessment and how they are used in engineering projects
- Be aware of resource scarcity, embodied energy, low energy/impact material choices, and the design choices that can reduce energy dependence
- Be aware of building physics and building environmental modelling (for those studying structural engineering)
- Provide an interdisciplinary perspective on the practical problems associated with sustainability
- Demonstrate knowledge of energy supply, and waste and water management
- Demonstrate knowledge of transportation, water supply, and coastal engineering
- Demonstrate knowledge of life-cycle assessment, sustainable communities and related infrastructure



Intellectual ability

Students will be able to:

- Appraise and question the purpose of a project and given brief, and consider its broad environmental, social and economic implications
- Appraise build options, maintenance, operation, demolition and deconstructions in the context of the sustainability agenda
- Look beyond mere technical design solutions and consider impacts on local stakeholders, including adaptability and other measures that ensure the completed construction remains fit for purpose over a considerable useful lifespan
- Assess and mitigate environmental risk in, for example, flood risk (including vulnerability of schools, hospitals etc.), slope stability and risk
- Develop a holistic approach to design
- Design for deconstruction and adaptability
- Demonstrate, through design studies, projects, coursework and/or examinations, a strong awareness of, and adherence to, carbon critical design and construction

Practical skills

Students will be able to:

- Demonstrate, through design work, projects, coursework and/or examinations, a strong awareness of, and commitment to, the principles of sustainable development

General transferable skills

Students will be able to:

- Provide solutions which are profoundly interdisciplinary in nature
- Appreciate the significance to society of the impact of human activity on the environment
- Demonstrate team working skills
- Communicate knowledgeably and clearly about sustainability issues, especially to those with a non-technical background
- Assess the embodied and operational carbon content of civil engineering projects

Learning and assessment methods

Teaching of sustainability should be embedded throughout the taught curriculum, including design projects, dissertation projects, coursework and examinations. Where sustainability is the focus of a particular unit, projects which encourage the use of practical case studies and site visits, where the ethos of sustainability has been embraced, will provide excellent learning opportunities. The JBM recommends that Annexes B, C and D are considered together, especially in relation to teaching and learning methodology and assessment.

ANNEX D: HEALTH AND SAFETY RISK MANAGEMENT IN DEGREE PROGRAMMES

Introduction

The decisions design teams and individuals make in the execution of civil engineering projects have an impact on the health and safety of others. The impact will be on those who are directly or indirectly involved with the project throughout the life of the project, from design to deconstruction (or demolition). Legislation puts duties onto all people involved in realising projects, and students must understand the seriousness of these duties and develop a mind-set that enables them to fully discharge their responsibilities. However, in addition to the fulfilling of statutory obligations, good safety risk management is a part of a successful buildable design.

Aims

Students will become attuned to the need to manage health and safety risks and to develop a fundamental grasp of the practical application of risk management more generally.

Knowledge and understanding

Students will:

- Understand the concepts of hazard and risk
- Understand the concept of the CDM approach of coordinated design risk management and be able to estimate the significance of risks, by attributing severity and likelihood
- Understand how risks can be mitigated and the importance of communicating residual risks to others.
- Understand that all decisions, whether in design or construction, potentially have an impact on how safe a project is to build, operate, maintain and deconstruct
- Be aware of key legislation relating to health and safety including:
 - The Health and Safety at Work etc. Act 1974 (The Health and Safety at Work Order 1978 in NI)
 - The Workplace (Health, Safety and Welfare) Regulations 1992
 - The Management of Health & Safety at Work Regulations 1999
 - The Construction (Design & Management) Regulations 2015
- Understand how risk management on a project is an ongoing process as the project develops and changes
- Understand the meaning of skills, knowledge, experience, training and organisational capability of individuals and organisations
- Use a famous failure case study to explain how things go wrong and identify the health and safety risks
- Understand the major causes of ill-health and serious injury in construction and how design decisions can affect this
- Identify and explain unusual or rare health and safety risks and distinguish these from ordinary or minor risks

Intellectual Abilities

Students will be able to:

- Identify hazards, estimate and prioritise risks
- Mitigate risk, manage residual risks, and review risks in the light of the progress of the project (in the context of a design project or laboratory experiment)

Practical skills

Students will be able to:

- Assess the hazards and risks for an aspect of project work and clearly communicate how the hazards and risks can be eliminated, reduced or managed
- Conduct themselves appropriately when undertaking field or laboratory work

General transferable skills

Students will be able to:

- Think 'laterally' and challenge assumptions
- Demonstrate team working skills
- Communicate clearly and knowledgeably about health and safety risk management

Learning and assessment methods

Teaching could be through elements of some modules but should be principally by raising awareness of the behaviours and attitudes required throughout the degree programme. Case studies, of failures, site visits, design office exercises and practical laboratory work, are recommended for the teaching of this subject. The JBM recommends that the three sets of guidelines (Annexes B, C and D) are considered together, especially in relation to teaching and learning methodology and assessment.



ANNEX E: INDUSTRIAL PLACEMENTS IN DEGREE PROGRAMMES

Introduction

Where an industrial placement is an integral part of a higher education programme of learning, it should be prepared for, and monitored, in the same way as all other parts of the programme. These guidelines are to be used when students spend a period of time on formal industrial placement(s) as part of a higher education programme of learning. The placement should be of such a length as to allow the student to participate to an appropriate depth and breadth, to gain relevant experience, and to learn within the workplace environment; it is generally accepted that, to achieve these aims, a placement will be of 12 months' duration (or two six-month periods). However, the following principles provide useful guidance for those programmes that offer vacation placement opportunities.

Preparation

Where a course of study includes an industrial placement, the higher education institution (HEI) must ensure that all students are formally made aware of the requirements. The programme handbook should set out who has the responsibility (student or HEI) for finding an industrial placement, together with the arrangements for undertaking, monitoring and formal assessment of the placement. Each HEI will have its own arrangements for finding placements, ranging from careers office job vacancy listings, arrangements with employers, through to student-identified opportunities.

Three months before the placement commences, the HEI should hold a briefing meeting to explain what can be achieved from the placement. The following items should be discussed:

- The learning opportunities that are likely to be encountered
- The assessment criteria relating to the learning outcomes
- The opportunities for professional development
- The understanding of the relationship between theory and practice

As part of the briefing, the HEI and the student should undertake a risk assessment and agree any control measures necessary to ensure the student's safety while on the placement. A pro forma and detailed guidance can be found in the publication [UCEA Health and Safety Guidance for the Placement of Higher Education Students](#).

For all placements, the formal arrangements covering legal and professional liability should be agreed with the employing organisation and discussed with the student.

Placement

As soon as practicable after the start of the placement, the HEI should ascertain the name of a suitable senior person within the employer's organisation who will act as a mentor to the student. Details of the professional bodies' Initial Professional Development (IPD) requirements for progression to professional registration as Incorporated or Chartered Engineers should be outlined to students.

When making arrangements for a placement, the HEI should discuss with the employer the potential opportunities for the student to be placed on any formal training scheme that the company may operate. In this way, IPD gained throughout the industrial placement may be formally recorded and assessed and could contribute to formal IPD requirements when students eventually enter graduate employment.

The HEI shall (whether through the employer's formal training scheme or otherwise) require the student to produce reports detailing his/her progress towards attainment of IPD objectives. When these reports are signed-off by the student's mentor they can form the basis for assessment of their professional development. Presentation of the reports should align with HEI procedures for submission of student input.

Details of the professional bodies' IPD, training and membership requirements can be found at:

[Institution of Civil Engineers](#)

[Institution of Structural Engineers](#)

[Institute of Highway Engineers](#)

[Chartered Institution of Highways and Transportation](#)

Monitoring

The arrangements for monitoring visits to the placement by HEI staff should be explained to students. Visits should be made at least twice in an academic year for a 12-month placement, and once during each of the two, six-month placements. For those on shorter placements (for example, 12 weeks), a visit should be arranged at an appropriate time. The HEI staff member should always have a meeting with the mentor and with the student's line manager (if that is a different person). A record of each visit should be prepared in a format that satisfies the HEI's requirements and provides a record of the student's learning and development. This may take the form of a report, or other suitable format, in order to provide an appropriate audit trail.

In order to lessen administrative inputs and alleviate extensive staff travel it may be appropriate to use technology, such as Skype or video/tele conferencing, to monitor student progress. If this is proposed, the practicalities should be discussed with the placement provider to ensure that IT security measures will allow this method to be used.

Completion

The entire placement should be recorded in a training report which should be submitted to the HEI. It should be used as a basis for a debriefing session during which students evaluate their own learning and are assessed on their achievements. Health and safety training should form an important part of this assessment.

The student should be required to make a 15-20 minute formal presentation about his/her placement, preferably to a peer group and staff. This should form part of the assessment.

The student should retain copies of their reports for future reference. HEI staff should encourage students to use their experience and their reports as a basis for a presentation to their professional engineering institution's local branch, regions or division, possibly during a 'papers' competition.

Awards

Where the placement learning is formally assessed as part of an award, the assessment will be in line with the HEI's regulations and will usually cover an interim assessment of the student's professional development, and a final assessment of the placement. Learning outcomes that are appropriate for the student's course of study should be agreed with the student. In selecting them, the HEI will need to balance the breadth of outcomes, the practicality and likelihood of achievement, and the effort required in monitoring and administration.

Learning outcomes for placements typically include:

- Demonstrating job-seeking and job-acquiring skills relevant to the chosen sector
- Identifying personal strengths and weaknesses in relation to the placement provider's needs
- Identifying key personal and professional development objectives in relation to the placement
- Evaluating personal and professional development against the objectives
- Understanding the placement provider's organisation and how the student fits within it
- Applying academic knowledge to professional practice
- Understanding and demonstrating appropriate professional behaviour
- Using the information gained on the placement to inform career goals

Interim assessment of the student's professional development will generally consist of monitoring visits, as described above, and written reports. Where the student has been placed on a provider's registered training scheme, the training reports can be used to record professional development and assess progress.

Final assessment of the placement and the grading of an award will follow HEI regulations. Where no criteria are in place, the award may be based on criteria which address the placement objectives, such as those in the table below:

Activity	%	Assessment	Notes
CV and cover letter	10	Pass \ Fail	Submitted before commencing, and updated following completion of the placement for tutor assessment. After placement, updated cover letter based on real live graduate vacancy.
Professional development audit	15	Pass \ Fail	Submitted at four points during the placement cycle coinciding with workplace visits.
Presentation	15	Graded	Delivered to peer group, or tutor, on return to HEI after completion of the placement
Final report	60	Graded	4000–6000 word report containing a minimum of 2000 words of personal reflection on the learning and development achieved on the placement. The balance of the report can be flexible to reflect specific experience.

Further Information

[ASET Good Practice Guide for Health and Safety for Student Placements](#) published by ASET

[Mini Guide to Professional Training Placements 2016/2017](#) published by the University of Surrey

[Health and Safety Executive](#)



ANNEX F – PROFESSIONALISM AND ETHICS IN DEGREE PROGRAMMES

Introduction

When students enrol on an accredited programme of study they commence their careers as professional engineers. The JBM believes that professionalism and ethics must be integrated and nurtured within teaching and learning throughout students' engineering education.

Aims

Students will gain an understanding of the rules and standards of professional and ethical conduct within an industry which seeks to enhance the public good. They will adopt an interdisciplinary focus in relation to the problems that engineers tackle in practice, and will develop a professional ethical identity to carry forward in their working lives.

As they progress their careers, it is expected that students will attain a professional qualification with one of the JBM member institutions and will be encouraged to become involved in the activities of their professional engineering institution(s).

Knowledge and understanding

Students will be able to:

- Understand the nature of professional responsibility
- Identify the ethical elements in decision-making
- Understand the interaction between engineering, the environment and society
- Understand how to overcome the practical difficulties in bringing about change
- Understand the implications of their professional engineering institution's code of professional conduct

Intellectual ability

Students will be able to:

- Appreciate the need to consider the ethical implications of decision-making
- Develop critical thinking skills and professional judgements
- Identify, address and resolve problems arising from questionable practice
- Evaluate the feasibility of options (identifying merits and drawbacks)
- Use engineering knowledge to find solutions to complex professional challenges
- Appreciate the need for continuing professional development



Practical and general transferable skills

Students will be able to:

- Work with complex/ill-defined problems
- Demonstrate individual and team working skills
- Communicate knowledgeably and clearly

Learning and assessment methods

Professionalism and ethics teaching should not be considered in isolation but must be embedded throughout the curriculum – including projects, coursework and examinations – to facilitate students' understanding, endorsement and demonstration of these values and competences.

The following are examples of the evidence that could be provided to the JBM to demonstrate how professionalism and ethics are embedded within a programme:

- Staff who are professionally qualified through a membership organisation such as the ICE, IStructE, CIHT and IHE
- A list of appropriate lectures given to students by professional engineers
- Evidence of the department's links with the local engineering community
- Examples of consultancy work undertaken by lecturers
- Confirmation that presentations concerned with engineering professionalism have been made by at least one of the JBM member professional institutions
- Evidence from student work
- A statement on plagiarism
- Examples of ethical solutions to problems
- Examples of appropriate use of key skills
- A statement on the impact of codes of conduct on the teaching of sustainability, health and safety, and ethics



ANNEX G: SITE VISITS IN DEGREE PROGRAMMES

Introduction

Site visits for engineering students provide an excellent 'shop window' for the many and varied career opportunities that construction industries have to offer. Visits may be linked to a relevant module, to a consultant's office or to a 'live' construction site, and can benefit everyone involved: the construction company looking to its long-term recruitment needs, the HEI needing to fulfil its JBM accreditation requirements, and the students who are looking to fulfil their career aspirations.

A common theme highlighted at JBM accreditation visits to universities is the lack of opportunities for students to undertake site visits, with the main reasons given as health and safety legislation, and/or a lack of local projects.

Health and safety requirements

Health and safety legislation does not prevent site visits – anyone can visit a site provided the visit is planned, organised and takes place under supervision that ensures the safety of the visitor – but practical issues, such as the lack of guides/hosts and/or appropriate personal protective equipment (PPE), may well stop a visit taking place.

Legislation does not permit someone to enter a site and wander around in an unsupervised manner. The visitor must have undertaken the necessary site induction and training; have been made aware of the risks and hazards that are present; and complied with basic site rules. For a site visit the visitor will be required to:

- Attend a site induction session
- Wear appropriate footwear and PPE (hard hats, goggles, high visibility clothing, gloves and ear protection)
- Comply with the instructions provided by the guide or host

The site induction will cover basic site rules and should not last an excessive amount of time. (It is no more onerous than the requirement to brief visitors to a university about the safety procedures operating within the campus.) Visitors may be asked to sign a form acknowledging that they have undertaken an induction session and signifying their agreement to comply with the visit procedures.

All construction sites require appropriate safety footwear and high visibility PPE to be worn at all times. Most importantly, footwear should be sturdy, providing ankle support and protection against puncture and/or permeation of substances. Steel toecaps and midsoles are now a general requirement to minimise the possibility of foot injury from potential sharp hazards on site.

The arrangements for provision of PPE should be discussed and agreed with the contractor prior to the visit taking place. Students may have access to appropriate footwear, either on a personal basis or through the university – it is required in laboratories and on field trips where the risk of foot injury is present – and, where this is the case, this can reduce the site workload in organising the visit. (It's important to remember that, when the student or HEI is providing PPE, the site rules regarding high visibility yellow or orange should be confirmed.)

If the student or HEI is unable to provide PPE and safety footwear the contractor may be able to do so. Major construction sites operated by leading contractors should be able to make the necessary provision but smaller sites may only have a limited range available and small group visits will be preferred.

Students will generally be shown around the site in small groups by the contractor's staff. This has the benefit of ensuring that the construction processes can be explained and discussed in detail and that appropriate levels of supervision can be provided to ensure the safety of all. There will be a limited number of areas where visits would not usually be appropriate, due to the highly specialised risks encountered and the training necessary for safe working. These areas include:

- underground tunnelling
- confined spaces
- work at height
- underwater and diving operations
- trackside on railway networks
- hazardous areas or operations (for example, asbestos removal or nuclear decommissioning).

Local site projects: maximising benefit of construction on campus

Many universities carry out significant construction work on campus as new facilities are provided to cater for increased student numbers and the provision of new courses. This provides an unrivalled opportunity for site visits as the university, as the client for the works, can control contractual arrangements. When commissioning a project, the university may seek to negotiate a programme of visits throughout the construction period at no cost. Indeed, in today's market, where engineering resources are at a premium, contractors should consider such arrangements as a recruitment opportunity which demonstrates their capability to provide employment to students when they graduate. In this situation, the JBM suggests a monthly site visit for a group of students would be acceptable.

The provision of vacation employment for an agreed number of students could also be considered. Depending on the scale of the project, this may incur a small additional cost for the HEI in procuring the project. Mutual benefit could be gained by the compilation of a video showing the construction methods and highlighting any innovation or new technologies being employed. Contracts generally include a requirement for progress to be documented photographically and the extension to provide video, if included in the tender instructions, should be possible at minimal cost.

All major contractors are required to have a corporate and social responsibility policy (CSR) as part of corporate governance, and the provision of site visits can form part of a contractor's CSR. The JBM suggests that universities, when seeking tenders for construction work or consultancy commissions, require organisations to submit their CSR policy and provide a proposal for addressing site engagement opportunities for students. This will enable a university, from its position as a construction client, to gain maximum benefit at minimal cost for its students.

The ICE's Membership Recruitment Team (MRT) may also be able to give guidance to universities on possible local site visits.

Local site projects: using industrial liaison panels

Many industrial liaison panel members proactively facilitate vacation work or employment for selected students, and members should be encouraged to arrange site visits to their projects as a benefit for all engineering students. Organisations which voluntarily contribute resources to the panel receive a return through the opportunity to recruit the most talented graduates.

To note: *Non-UK programmes should check local health and safety guidelines.*

ANNEX H: INDUSTRIAL INFLUENCE AND INPUT IN DEGREE PROGRAMMES

The JBM believes that, in the same way that professional experience can enrich a student's learning, degree courses can benefit considerably from engagement with the civil engineering profession. For this reason, the JBM strongly recommends that higher education institutions (HEIs) maintain strong, viable and visible links with the civil engineering profession.

As part of the accreditation process, the JBM will be seeking evidence that such links are in place and that they are effective.

The JBM actively encourages schools/departments to consider establishing an Industrial Advisory Board and the following is offered as guidance as to what an effective Board might look like:

- Approximately 10 members with collective expertise to cover the full range of the school/department's activities
- The chair should be an industrialist and not an academic
- The Board should meet two times a year as a minimum

The advice that the Board provides will depend on the HEI and the particulars of the course but might include the following:

- Undergraduate programmes and the perceived needs of industry
- Professional training year placements
- Possibilities for workplace and other forms of distance learning
- Sponsorship of taught students in a fee-paying environment
- External links with potential sponsors of research
- Sponsorship of research projects and research students



ANNEX I: SURVEYING IN DEGREE PROGRAMMES

Introduction

Geospatial Surveying/Geomatics integrates the collection, processing, analysis, presentation and management of spatial information. It is an all-encompassing term that includes land surveying, setting-out, geodesy, photogrammetry, engineering surveying, hydrographic surveying, mine surveying and cartography, together with the recently-developed disciplines of geospatial information systems, remote sensing and laser scanning.

The geospatial surveying subjects most commonly taught as part of a JBM-accredited degree programme include land surveying and setting-out, commonly referred to collectively as 'engineering surveying' or simply 'surveying' (the latter term will be used in the remainder of this annex).

JBM-accredited IEng, BEng and MEng programmes should be constructed around at least five (of a possible 10) core subjects (see part 2, section 3.3). Where surveying is not included as a core element, the JBM expects the fundamentals to be covered elsewhere in the degree programme.

Surveying facilitates creative thinking, collaboration and team working and is one of a few subjects where practical skills are actively developed. Employers expect student engineers and graduates to be competent when using instruments, have well developed free-hand sketching skills, and the ability to create and maintain clear records.

The JBM is keen to avoid over-prescription and encourages HEIs to facilitate students' development of surveying to a level considered suitable for their own programmes, providing that the fundamental knowledge and skills, as set out within these guidelines, are met.

Aims

Through their studies of surveying, the JBM expects students to gain:

- An understanding of the significance and limitations of spatial information and dimensional control for civil engineering design and construction
- An understanding of how spatial information is collected, processed and used in practice
- The theoretical knowledge and practical skills necessary for employment as a junior engineer involved with surveying or setting-out on a construction project

Knowledge and Understanding

Students will have knowledge and a developing understanding of:

- The use of spatial information in design and construction projects
- The means of obtaining spatial information including specification, procurement and administration of surveys, taking into account issues of professionalism and ethics
- Surveying instrumentation commonly used on construction projects
- Basic techniques used for establishing survey control, undertaking detail surveys and setting-out
- Procedures for practical surveying and setting-out
- Observational and computational errors
- The use of survey data in design practice including receipt, manipulation and checking of data prior to use
- A basic understanding of Global Navigation Satellite Systems (GNSS) and application to surveying and setting-out
- A basic understanding of point clouds and their use to represent spatial features, including acquisition (e.g. laser scanning/structure from motion photogrammetry), registration and information extraction (basic geometry and 3D modelling for BIM)
- The information and services provided by national mapping organisations (e.g. Ordnance Survey)
- The basics of coordinate systems, including local scale factors, and height datums

- Health and safety issues in the context of surveying of sites/structures and setting-out on site, specifically the ability to appreciate the significant risks associated typically with previous use, state of repair, occupancy, etc:
 - of existing buildings being surveyed
 - when working near to plant or construction activities on a construction site; and
 - during the detection and tracing of underground utilities
 -

Intellectual Abilities

Students will be able to:

- Explain the principles and techniques involved in establishing control, detail surveying and setting-out on site
- Specify basic principles and methods used to measure spatial elements (i.e. coordinates, directions, distances, height differences)
- Outline the nature of observational errors, apply variance propagation and recognise the benefits of least squares estimation
- Explain the role of standards and specifications in surveying and setting-out, and perform relevant survey calculations
- Explain the use of spatial information in design and construction projects, and outline the means of obtaining spatial information in practice

Practical Skills

Students will be able to:

- Demonstrate the practical skills necessary to use surveying instruments commonly employed on construction projects for surveying and setting-out, with practical and fieldwork activities configured for all students' physical abilities and sightedness
- Use relevant data processing and survey adjustment software
- Present field records and derived data in a clear professional manner, and use survey data effectively in design work

General Transferable Skills

Students will be able to:

- Work as team members
- Solve technical problems using numerical methods
- Present technical information in a variety of ways (oral, written, graphical)

Method of Teaching, Learning and Assessment

Delivery of the modules should preferably be through a mixture of lectures, tutorials and practical work. The practical aspect of the modules is considered essential because the field environment accelerates the development of both subject and transferable skills and provides students with direct opportunities for employment. This element should be achieved through regular practical sessions and/or (preferably) a residential field course.

Part Two: Guidelines for Developing Degree and Further Learning Programmes for:

- MEng programmes leading to Chartered Engineer
- BEng (Hons) programmes as a route towards Chartered Engineer
- Bachelor's degree programmes leading to Incorporated Engineer

1. Programme Objectives

While degree programmes conforming generally to these guidelines will vary in style and content, a general objective of any accredited engineering programme is to provide the distinctive educational base that will produce graduates who are practical, articulate, numerate, literate, imaginative, versatile, confident and inquisitive. For this reason, these guidelines, which previously were in three separate JBM documents, have now been updated in line with the Engineering Council's (EngC) Accreditation of Higher Education Programmes (AHEP) and arranged alongside each other so that comparisons between the different types of degree programmes can be more easily made.

Note: In the following tables i = IEng b = BEng m = MEng

BSc (IEng)	BEng	MEng
<p>1.1i Bachelor degrees meeting the academic standing for accreditation at IEng (hereafter referred to as an IEng degree) will contain no fewer than 300 credit accumulation transfer points, of which no fewer than 60 are at Level 6. IEng programmes will have an emphasis on developing and supporting the aptitude necessary to apply technology to engineering problems and processes, and to maintain and manage current technology at peak efficiency. An IEng degree will have an emphasis on industrial application. Where possible the programme should include an individual or group project.</p> <p>IEng programmes may be specific to one engineering discipline, broadly based over a range of disciplines, or include major subsidiary subjects such as business, management, languages, environmental sciences, always provided that mainstream engineering science and technology dominates, whether of a single or multi-disciplinary nature.</p> <p>The structure of the IEng programme will place emphasis on teaching skills and knowledge which make use of the application of engineering principles and standards and codes of practice, rather than exploring in depth the theory behind the standards and codes. The teaching of mathematics should be aimed at developing an ability to use analytical techniques in practical solutions and may be taught as stand-alone or within a subject it is relevant to.</p>	<p>1.1b BEng (Hons) graduates with Further Learning ...</p> <p>... should have the potential to take responsibility for innovation, technology transfer and change, will seek ways of exploiting emerging technologies and, where appropriate, promoting advanced designs and design methods. They will need to possess creativity founded upon a deep understanding of engineering principles and may eventually control projects involving advanced technology that require the management of risk, resources and large capital budgets. Professional judgement and application are likely to be key features of their role allied to the possibility of responsibility for the direction of important tasks including the profitable management of industrial and commercial enterprises and the supervision and management of others.</p>	<p>1.1m MEng graduates ...</p>
<p>1.2 All graduates will need to develop an understanding of the construction industry, its role in wealth creation, the social and political context within which engineering is practised, the role of civil engineering in shaping the physical and social environment and its diverse contribution to the quality of life and social justice.</p>		

2. Programme Characteristics

BSc (IEng)	BEng	MEng
<p>2.1i An accredited IEng is defined by the EngC as a first cycle degree of three academic years duration full-time programme (or equivalent part time or programme with placement year) at a minimum QAA Level 6 (Intermediate)/SCQF Level 9. The aim of the IEng degree is to develop the skills, knowledge and attributes which Incorporated Engineers will be expected to display. The programmes will reflect national rather than local needs, but with subjects appropriate to the specific field of engineering, and will be taught with an applications bias.</p> <p>Consequently a degree programme, which meets the IEng requirement, should cultivate:</p> <ul style="list-style-type: none"> ▪ Technical proficiency of a high level in a major field of engineering, including the ability to tackle a wide variety of practical problems, however specialised. ▪ A professional attitude towards matters such as the design reliability and maintenance, sustainability, product quality and value, marketing and safety. ▪ Oral, written and graphical communication skills. ▪ A professional approach to relationships with clients, customers and colleagues, including supervision of staff, and the ability to work as a member of an engineering team within an ethical framework. ▪ An appropriate exposure to environmental, sustainability, health, safety and risk management considerations for staff and the general public. <p>The IEng degree may build upon an HNC/D or a Foundation Degree but is distinguished principally by:</p> <ul style="list-style-type: none"> ▪ The extended nature of the project work in the degree. ▪ The increased level of specialist study in the degree. ▪ A broader and more general educational base in the degree course, to provide an educational foundation for leadership, social and business awareness and for an appreciation of risk, environmental, health and safety and social issues. 	<p>2.1b The BEng (Hons) is defined by the EngC as a first cycle degree of three academic years' duration (or equivalent part time or programme with placement year) and should be at QAA Level 6 (Higher/ SCQF Level 10).</p> <p>Both types of degree are intended for students with demonstrably high academic achievements and motivation, and should provide a coherent and integrated broad based programme of foundation and specialist learning in a high quality learning environment. Both should be supported by the development of personal and professional competencies including information technology and be delivered against a background of current business and commercial practice and preferably include consideration of international issues.</p>	<p>2.1m The MEng is defined by the EngC as an integrated second cycle degree (or equivalent part time or programme with placement year) and the majority of the final year modules should be at QAA Level 7 (Higher/ SCQF Level 11).</p> <p>The MEng will have a demonstrably significant additional amount of extended study by comparison with that required of BEng (Hons) programmes.</p>

2.2 Standards of academic achievement for entry into all degree programmes will continue to form an important criterion for accreditation (see Part One, Annex A, Achievement Levels for Entry onto Degree Programmes). However, the guidelines reflect the need for accreditation to be focused more upon the standards of achievement that are attained during the programmes and the standards reached upon completion of the programme.

BSc (IEng)	BEng	MEng
<p>2.3i Core and supportive subjects appropriate to the role of an Incorporated Engineer should be identified. It is likely that some programmes will concentrate on specific subjects that they will treat in some depth, and this should be encouraged, provided it is not at the expense of core subjects.</p>	<p>2.3 The content of MEng and BEng programmes will vary within the range of disciplines embraced by the JBM and will be influenced by the needs of different sectors and employers. It is anticipated that both programmes will vary in emphasis between one university and another, but they should be designed to provide the base for differing careers within the same discipline. Both MEng and BEng should provide depth and breadth, an intellectual approach and the development of an ability to identify, define and solve complex problems from first principles.</p>	<p>Moreover, MEng students should demonstrate less reliance on standardised solutions and empiricism.</p>
<p>2.4i Universities can submit details of degree courses from associated disciplines such as specialist technology courses but the core areas in paragraph 3.3 would need to be covered in order that the programme can be accredited.</p>	<p>2.4 Both MEng and BEng programmes should create the platform from which individual aspirations to register as a Chartered Engineer can develop, and therefore it is essential that a recognised minimum of engineering science and technology be safeguarded within the programme as set out in 3.2. There may be variations in emphasis for study of a particular branch of engineering with some developing greater breadth and others greater depth. There should be industrial involvement in both the design and delivery of programmes. Both programmes shall include a substantive investigative project with an individual report.</p> <p>2.5b The BEng can be broadly equivalent to the first three years of the MEng, with the principal differences being the technical and non-technical broadening and deepening, and the experience gained from working in a group project integrating earlier course components – all of which are made possible by the additional year for the MEng. In that BEng graduates can, with further learning, eventually become registered as Chartered Engineers, the academic standards of the BEng should be basically equivalent to those of the first three years of the MEng degree.</p>	<p>Additionally, for the MEng, there will be diversity in the extent of multi-disciplinary education in a range of engineering disciplines, and differences in the extent to which elements of business issues and practice, including management, finance, marketing and cost control are covered.</p>



3. Academic Requirements

BSc (IEng)	BEng	MEng
<p>3.1i Within an IEng degree programme, about 60% of the course could be taken up by subjects involving mathematics, calculation, experiment, observation and deduction. Of the remainder, there should be sufficient civil engineering subjects, as well as other subjects relevant to civil engineering which broaden the student's appreciation of the work in the construction, transport or built environment industry and the interaction of the engineer with society, environmental, and health, safety and risk management issues.</p> <p>3.2i An IEng degree programme should place emphasis on application of principles, engineering science and knowledge and must have acceptable engineering content in the curriculum. In broad terms, the application of engineering science, including relevant mathematics, which may be delivered within a subject, should constitute around 40% of the programme,</p>	<p>3.2 Both BEng and MEng programmes should place emphasis on a fundamental and thorough understanding of the principles of engineering science, with a greater expectation of emphasis for the MEng. Students should be able to identify, understand and apply the principles with confidence. An understanding of the concept of stability and modes of failure, referred to in 3.5, will complement this understanding. In broad terms the development of engineering sciences (including relevant mathematics) should constitute around 50% of the programme, with the emphasis dependent upon the nature of the degree programmes.</p>	<p>3.1m The essence of an MEng programme is the education of students to an appropriate depth of understanding and breadth of knowledge needed to work within and, eventually, to lead and manage inter-disciplinary teams. Because the MEng is designed for students with high academic ability and motivation, these programmes need to make provision for:</p> <ul style="list-style-type: none"> ▪ sufficient time to achieve the standards of the educational base for a Chartered Engineer ▪ analytical treatment, comparable in depth intellectually, to the highest standards for undergraduates ▪ both depth and breadth of coverage to meet the needs of industry in technical subjects, management and business topics and personal skills ▪ a foundation for a wide range of subsequent study and the development of a positive attitude and motivation towards lifelong learning.
<p>3.3 The engineering content of all IEng, BEng and MEng programmes should be constructed around at least five core subjects from those listed below that are appropriate to the institutions concerned in the accreditation of civil, structural and highway engineering programmes. These core subjects should be reflected in the aims of the degree programmes, and they should embrace theory, analysis, design and engineering practice. They should also provide an appropriate integration of the engineering sciences, mathematics, mechanics and materials.</p>		



The JBM would expect to see degree programmes that contain the three core subjects in LIST A:

- **structures**
- **materials**
- **geotechnics**

AND a minimum of two core subjects chosen from LIST B:

- **fluid mechanics (hydraulics)**
- **surveying (geomatics and measurement)**
- **transport infrastructure engineering**
- **public health**
- **construction management**
- **environmental engineering**
- **architectural technology**

3.4 The chosen core subjects should be developed to a depth where the time spent on them represents at least one quarter (for IEng) or one third (for BEng and MEng) of the total curriculum. If fluid mechanics and surveying are not included within the core subjects, then the JBM would expect to see the fundamentals of these subjects covered elsewhere in the degree programmes. It is anticipated that programmes would cover at least introductory aspects of most of the subjects listed above that are not included in a core selection. Where specialist optional core subjects other than those listed above are introduced, their inclusion must be justified and it must be demonstrated that there remains a balance of core subjects which will provide the right foundation for a career in the construction and environment sectors. The degree programme should build on these subjects to meet employment needs and progression to further academic studies.

3.5 The engineering subjects should be taught in the context of design (see Part One, Annex B, Design in Degree Programmes) with appropriate account of issues of:

- sustainability (see Part One, Annex C, Sustainability in Degree Programmes)
- health and safety (see Part One, Annex D, Health and Safety Risk Management in Degree Programmes)
- construction.

Each issue should continuously and progressively run through the programme, exposing students to a thorough mixture of engineering principles:

- the concept of stability
- modes of failure
- analysis
- and, for *BEng and MEng programmes*, synthesis, and conceptual design.



BSc (IEng)	BEng & MEng
[Purposely blank]	Through contact with other issues, BEng and MEng students should be stretched to ensure development of their capabilities to operate at a high intellectual level, including the exercise of judgement.

For all students, an ability to demonstrate engineering concepts and ideas using sketches and diagrams will enhance the level of understanding and will complement the communication skills referred to in 3.11.

BSc (IEng)	BEng & MEng
3.6i In order for a course to be accredited the JBM would wish to see a coherent, balanced and integrated programme of learning and development to meet current and foreseeable future needs of the professions.	3.6 The teaching of mathematics, both as an identifiable discipline as well as its use in developing engineering theory, is important and should run for at least two years of the programme. Elements involving calculation, experiment, observation and deduction, must form a significant part of the programme.
3.7i Units of study at any level outside these guidelines may be introduced but their inclusion must be justified.	3.7 Experimental work is important and should extend beyond routine classical testing and experiments in the laboratory. Field courses in subjects such as surveying, geology and environmental issues are also important, particularly where these subjects form an integral part of the programme.
3.8i All students should be competent in the use of computers and familiar with current examples of software available in the construction industry. Emphasis should be placed upon the solution of practical problems by the use of appropriate modern methods and technology.	3.8 Broadening subjects outside core engineering should form an important element in an accredited programme. Wherever possible, departments should provide opportunities for students to follow, in various degrees of depth, a range of appropriate subjects. Learning to recognise and manage risk, in its broadest sense, should be an integrated element of all courses. This will involve the student in technical assessment and management (including project and budgetary control), and an understanding of environmental and occupational health and safety risks.
3.9i Graduates must have an understanding of environmental issues and the ability to take them into account in design and construction processes. The concepts of sustainability, acceptability and assessment should be introduced (see Part One, Annex C, Sustainability in Degree Programmes).	

3.10 An understanding of health and safety issues and the need to design and operate safe systems of work is mandatory for practising engineers; programmes must expose students to the wider social, commercial and legal contexts and engender an appreciation of the value of design and of good practice in the reduction of risk (see Part One, Annex D, Health and Safety Risk Management in Degree Programmes).

3.11 Communication skills and working with others are imperative for all engineers.

BSc (IEng)	BEng & MEng
For the IEng, these may be delivered and assessed using the national key skills, which form part of the National Vocational Qualifications (NVQs) framework. Achievement at level 4 would be appropriate for students on first degree programmes.	[Purposely blank]

It is fundamental that engineers of all types are able to communicate with confidence and clarity to their professional colleagues, the public and the other professions. All programmes should develop effective verbal and written communication skills, including public speaking and the preparation and presentation of written material in clear precise and grammatically correct English. Students should be encouraged to create and use sketches and diagrams as a direct means of communication or to complement written material or verbal presentation.

BSc (IEng)	BEng & MEng
[Purposely blank]	<p>3.12 Effective communication interfaces with the requirements and responsibilities of leadership, as well as working within an interdisciplinary team. An opportunity to learn and to use other languages should be encouraged.</p> <p>All students should be encouraged to develop competency in the use of computers and IT skills. It is important that the use of computers should reinforce the understanding of basic principles, concepts and limitations.</p> <p>Sustainability issues in their broadest sense are of vital concern in professional engineering. It is important that graduates have an understanding of these and are able to take them into account in the design and construction processes. Wherever relevant, these issues should be woven into the separate subjects within the programme (see Part One, Annex C, Sustainability Development in Degree Programmes).</p>



All programmes should introduce the concept of quality systems and the need for a quality approach to be intrinsic to all activities.

BSc (IEng)

3.13i The JBM believes that project work is an important means of introducing a professional approach to engineering studies. For this reason, the use of projects as a vehicle for the integration of subject areas is strongly recommended throughout the IEng programme. Normally, the final year of the programme should include an intellectually challenging project, which could be an individual project, or an integrated group project, which would be individually assessed. The project should pull together the various strands of the course, particularly addressing design synthesis, application and creativity of an engineering application. The assessment of the project should be against criteria for both the process leading to the final project product and also the outcome itself. The project should then be a significant factor in the final award.

3.14i In the final year of the programme, emphasis should be placed upon:

- An integrated design project for the built environment using relevant IT.
- The development of skills and the application of knowledge.
- Professional studies including economics, finance and management, legislation, health and safety, sustainability.
- Group and individual work in engineering subjects.
- The development of exploratory learning by students themselves from departmental resource materials, the education institution and industry.

3.15 There should be strong, viable and visible links between departments and the profession. It is essential for BEng and MEng (and desirable for IEng) that local practising engineers should become involved with the education of students by, for example, giving appropriate lectures, internal talks, assisting with design projects, acting as industrial tutors, and enabling students to make site visits. Regular site visits should be seen as an important element within the programme. It is strongly recommended that an industrial liaison group is established and should meet regularly to implement change and identify how local and national needs for graduate employment might influence programmes.

BEng & MEng

3.13 All BEng and MEng students should undertake a major investigative project in a subject that is not of a routine nature, which will lead to an individual report. This should provide scope for initiative, creative thinking, understanding the research method, and should be intellectually challenging and individually assessed. Where research is taking place within the department, every endeavour should be made to see that students are exposed to, and are aware of, these activities. Additionally, students should be engaged in a group design project, preferably interdisciplinary, which provides opportunities for integrating earlier modules, and will assist in the development of team working. Both forms of project should normally be linked to real problems. These projects should be undertaken within the final two years of the programme.

3.14 Programmes should not be overloaded and need to encourage the development of exploratory self-learning. Time should be available within the programmes to allow students to take advantage of a range of other opportunities.

4. Mapping to AHEP Learning Outcomes

All programmes must provide a 'mapping table' to demonstrate how the AHEP Learning Outcomes applicable to all engineering programmes (see 4.1 below) are met in the individual modules/units of the programmes.

For the purpose of the mapping, the following definitions apply:

- **Awareness:** general familiarity, albeit bounded by the needs of the specific discipline
- **Knowledge:** information that can be recalled
- **Understanding:** the capacity to use concepts creatively, for example in problem solving, design, explanations and diagnosis
- **Know-how:** 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
- **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

4.1 AHEP Learning Outcomes

Note: In the following tables i = IEng b = BEng m = MEng

Science and Mathematics (SM) Engineering is underpinned by science and mathematics, and other associated disciplines, as defined by the relevant professional engineering institution(s). Graduates will need the following knowledge, understanding and abilities:		
IEng	BEng	MEng
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 their engineering discipline, 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 their engineering discipline, 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 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	SM2m 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
	SM3b Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline	SM3m Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively

		SM4m Awareness of developing technologies related to own specialisation
		SM5m A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, 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 effectively in engineering projects

Engineering Analysis (EA)		
Engineering analysis involves the application of engineering concepts and tools to the solution of engineering problems. Graduates will need:		
IEng	BEng	MEng
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	
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 appropriate action
EA4i Ability to apply an integrated or systems approach to engineering problems through knowledge of the relevant technologies and their application	EA4 Understanding of, and the ability to apply, an integrated or systems approach to solving 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 and complex problems. Graduates will therefore need the knowledge, understanding and skills to:		
IEng	BEng	MEng
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	
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	
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 designs 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	
D5i 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		
		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 impacts 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:		
IEng	BEng	MEng
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 conduct 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		
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	
EL5i Awareness of the relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues	EL5b Awareness of relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues	EL5m Awareness of 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 and 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 skills, combining theory and experience, and use of other relevant knowledge and skills. This can include:		
IEng	BEng	MEng
P1i Knowledge of contexts in which engineering knowledge can be applied (for example operations and management, application and development of technology, etc.)	P1 Understanding of contexts in which engineering knowledge can be applied (for example operations and management, application and development of technology, etc.)	
P2i Understanding of and ability to use relevant materials, equipment, tools, processes, or products	P2b Knowledge of characteristics of particular materials, equipment, processes or products	P2m Knowledge of characteristics of particular 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	
P4i Ability to use and apply information from technical literature	P4 Understanding of the use of technical literature and other information sources	
	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	
P7 Awareness of quality issues and their application to continuous improvement		
	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 learning outcomes, that will be of value in a wide range of situations, including the ability to:

IEng	BEng	MEng
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		
G3i Plan and carry out a personal programme of work	G3b Plan and carry out a personal programme 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	



5. Courses which include Placements, Vacation Work Experience and Work-Based Education

BSc (IEng)	BEng & MEng
5.1i Students on IEng degree courses will normally be expected to gain some practical work experience or training during their degree programme.	5.1 BEng and MEng undergraduates will enhance their academic knowledge, and graduates will be more appreciated by their first employer, if they have gained some industrial experience or training during their degree programme.

This experience or training may be obtained during the industrial periods of a placement year or during the long vacations, preferably in periods of at least eight weeks duration. In either case, it is preferable if the students are introduced to engineering applications both on site and in the design office where they can form an integral part of the degree programme. Where they form part of the degree programme, universities should monitor all periods of industrial experience, with the undergraduates required to produce reports on their experiences.

5.2 Students receiving placement year/vacation/industrial experience should expect to participate in any training/development opportunities that are available.

5.3 Site visits and attendance at professional body/institution meetings are important elements of engineering education and the JBM actively encourages these activities. Direct links between universities and professional bodies are encouraged (see Part One, Annex G, Site Visits in Degree Programmes).

5.4 Good practice for industrial placements is outlined in Part One, Annex E, Industrial Placements in Degree Programmes.

5.5 It is possible for the JBM to accredit work-based education that is designed as part of an accredited degree programme. Work-based education in a degree programme can include work placements, work placements as part of a module, vacation placements, and a placement year. A degree programme is made up of periods of learning which are assigned credits. An undergraduate year (usually 30 weeks of formal education) is equivalent to 120 credits. The credits for work-based education are different because the student is developing professionally while acquiring knowledge in the work place.

BSc (IEng)	BEng & MEng
<p>5.6i For the IEng, a work-based education module is a more intense learning experience than a placement. In both cases there has to be an individual learning plan for each student.</p>	<p>5.6 Work-based education modules or placements that bear credits normally occur between the end of the second year (third year in Scotland) and graduation (although this may be different if the work-based education modules are divided into a 'thin placement' structure). Please refer to the JBM Guidelines for Work-based Education forming part of the educational base for a Chartered Engineer (FLJBM10): the modules have to meet the principles described in Section 3: Process, and Section 4: Assessment; and the learning outcomes (see Appendix A) and the appropriate level of competency (see Appendix B) have to fit within the accredited degree programme.</p> <p>5.7 A work-based education module is a more intense learning experience than a placement. In both cases there has to be an individual learning plan for each student.</p>

5.8 The assessment is based on a **portfolio of evidence**, including an explanation to place the evidence in context, and how the key learning outcomes were achieved; a number of **assignments that test the knowledge and understanding and the ability to apply that knowledge**; and an **oral presentation**.

6. Extra Mural Activities

It should also be remembered that many qualities upon which employers place considerable importance are developed by involvement with activities external to the department, so these should be encouraged.

7. Programme Amendments

Planned substantial modifications to an accredited programme should be notified to the JBM.

