JBM Guidance on providing evidence for programmes of Further Learning to an appropriate level for IEng.

Introduction

Incorporated Engineers will have the know-how necessary to apply technology to engineering problems and processes and to maintain and manage current and technology, sometimes within a multidisciplinary engineering environment. They can be expected to be undertaking engineering design, development, manufacture, construction and operation. Incorporated Engineers will be variously engaged in technical and commercial management and should possess effective interpersonal skills. (UK SPEC)

In this context Further Learning comprises the additional educational achievement necessary to bridge the gap between an approved HND/Foundation Degree or equivalent and an accredited BSc degree for an Incorporated Engineer. Where appropriate, elements of Further Learning can be integrated with IPD but must be recorded and assessed separately.

This document is guidance, not requirements. The opportunities available for learning will vary with the nature of each participant's work as a professional engineer and therefore the further learning plan should be tailored to the individual and their work/company context. Work opportunities provide a springboard for the required further learning, but additional private study will almost certainly be needed to enable participants to fully meet all the requirements.

The expectation of the JBM is that the Learning Outcomes (LO) can be addressed as outlined below but it is emphasised that this is only indicative guidance and that it is the responsibility of each participant to prepare a learning plan of how they propose to achieve the desired educational base and, more importantly, evidence which demonstrates they have done so, to the satisfaction of the assessors. Some examples of activities and evidence are given as guidance of how an LO can be completed, but it is emphasised that the wording of the LO itself is the high level requirement, not the activities or examples as described. Other activities and evidence may be used to demonstrate the required learning.

All 18 LOs have to be achieved; although evidence from a single activity can be used for more than one LO (e.g. 'separate' evidence is not required for each LO). The participant's portfolio should contain a brief reflective statement for each LO that describes the activities undertaken and provides evidence as to the LO has been achieved. It is appreciated that engineers usually work in teams, with supervision/oversight, so the evidence should make clear what their input was to each example, and how that related to the wider team.

Summary

The 18 Los can be grouped under 5 headings (**Science and Mathematics, Engineering Analysis, Design, the Engineer and Society and Engineering practice**) they are numbered B1 – B18 for a bachelor honors degree. The Learning Outcomes listed below are those for a top-up degree designed to meet further learning requirements fir an Incorporated Engineer and a number of these will have already been satisfied by the student if they have completed an accredited or approved Foundation Degree or a HND. If the academic provider or an employer wishes to offer a further learning programme at bachelor honors level, they should refer to the listing of learning outcomes in the JBM Guidelines for an accredited learning degree or in the Engineering council publication, Accreditation of Higher Education Programmes.

Engineering is **underpinned by** Science and Mathematics, and other associated disciplines, as defined by the relevant professional engineering institution(s). On successful completion of an approved or accredited programme, an individual will be able to:

Science and Mathematics. The study of engineering requires a substantial grounding in engineering principles, science and mathematics commensurate with the level of study.

Science, mathematics and engineering principles. B1. Apply knowledge of mathematics, statistics, natural science and engineering principles to broadly-defined problems. Some of the knowledge will be informed by current developments in the subject of study.

Engineering Analysis involves the application of engineering concepts and tools to analyse, model and solve problems. At higher levels of study engineers will work with information that may be uncertain or incomplete.

Problem analysis – **B2**. Analyse broadly-defined problems reaching substantiated conclusions using first principles of mathematics, statistics, natural science and engineering principles.

Analytical tools and Techniques - B3. Select and apply appropriate computational and analytical techniques to model broadly-defined problems, recognising the limitations of the techniques employed.

Technical literature B4. Select and evaluate technical literature and other sources of information to address broadly defined-problems.

Design and innovation - Design 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 commensurate with the level of study.

Design B5. Design solutions for broadly-defined problems that meet a combination of societal, user, business and customer needs as appropriate. This will involve consideration of applicable health and safety, diversity, inclusion, cultural, societal, environmental and commercial matters, codes of practice and industry standards.

Integrated/systems approach B6. Apply an integrated or systems approach to the solution of broadly-defined problems.

The engineer and society Engineering activity can have a significant societal impact and engineers must operate in a responsible and ethical manner, recognise the importance of diversity, and help ensure that the benefits of innovation and progress are shared equitably and do not compromise the natural environment or deplete natural resources to the detriment of future generations.

Sustainability ***F7.*** Evaluate the environmental and societal impact of solutions to broadly-defined problems. *The Example of the F7 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Ethics B8. *Identify and analyse ethical concerns and make reasoned ethical choices informed by professional codes of conduct.*

Risk B9. Use a risk management process to identify, evaluate and mitigate risks (the effects of uncertainty) associated with a particular project or activity.

Security ***F10.*** Adopt a holistic and proportionate approach to the mitigation of security risks. *The Example of the F10 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Equality, diversity and inclusion ***F11.*** Recognise the responsibilities, benefits and importance of supporting equality, diversity and inclusion. *The Example of the F11 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Engineering practice. The practical application of engineering concepts and tools, engineering and project management, teamwork and communication skills. Engineers also require a sound grasp of the commercial context of their work, specifically the ways an organisation creates, delivers and captures value in economic, social, cultural or other contexts.

Practical and workshop skills F12. Use practical laboratory and workshop skills to investigate broadly-defined problems. *The Example of the F12 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Materials, equipment, technologies and processes F13. Select and apply appropriate materials, equipment, engineering technologies and processes *The Example of the F13 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Quality management F14. Recognise the need for quality management systems and continuous improvement in the context of broadly-defined problems. *The Example of the F14 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Engineering and project management - B15. Apply knowledge of engineering management principles, commercial context, project management and relevant legal matters.

Teamwork F16. Function effectively as an individual, and as a member or leader of a team. *The Example of the F16 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Communication F17. Communicate effectively with technical and non-technical audiences. *The Example of the F17 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Lifelong learning F18. Plan and record self-learning and development as the foundation for lifelong learning/CPD. *The Example of the F18 Learning Outcome is included for completeness and those students with appropriate qualifications will have achieved this Learning outcome achieved at their previous level of study.*

Bachelors' Level

Some examples of general approaches that can help a participant demonstrate Bachelors' level learning on the topic of a learning outcome are:

- Using one (or perhaps two) specific examples that they have been active in – examples are much more effective evidence than general claims/statements
- Showing an ability to apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding and to initiate and carry out projects
- Being able to demonstrate that they can critically evaluate arguments, assumptions and data (that may be incomplete), to make judgements, and to frame questions to achieve a solution to a problem
- Providing evidence of exercising initiative and personal responsibility
- Demonstrating assessment of a range of risks for a project and appraisal of the relative merits of mitigation options, with an ability to convey this concisely
- Evidence of being able to communicate information, ideas, problems and solutions
- Highlighting reflection on formal learning from courses, seminars and the like, and how this has been applied in the workplace

NB These are not the only approaches!

Guidance on Bachelors' level characteristics that assessors look for in the portfolio that a participant prepares for demonstrating their further learning to Bachelors' level is available from a number of sources, for example:

- The Accreditation of Higher Education Programmes (AHEP), 4th edition published by the Engineering Council

- The Accreditation and Approval of Qualifications and Apprenticeships published by the Engineering Council
- Quality Assurance Agency for Higher Education
- SEEC level descriptors:

Guidance on Bachelors' level marking/assessment/grade criteria is also available, for example:

- Kingston University

(links correct at July 2021)

Preamble to the examples of activities and evidence for each learning outcome (LO)

1. The key requirement is to demonstrate Bachelors' level learning on the topics of the LOs. The name of the broad areas under which LOs are listed also indicates the area in which evidence should be provided.
2. Attention is drawn to the notes on Bachelors' level learning earlier in this document.
3. The aim of the examples of activities and evidence given in the following Tables is to try and assist participants, their employers and mentors to identify activities and evidence available in the context of their own work as professional engineers that could serve as a springboard to show Bachelors' level learning in the various LOs. The activities and examples of evidence are NOT prescriptive; there are many other activities and topics of evidence that could also enable a participant to demonstrate the required Bachelors' level learning. Demonstration of that learning is the key aim for the participant. Evidence presented that is about one of the example topics listed but which doesn't show Bachelors' level learning on that LO will not be acceptable.
4. Several examples of activities and evidence are given in the following Tables, but **the evidence required for a participant would typically only need one, or perhaps two, relevant examples of evidence from that engineer's work, treated in depth to show their Bachelors' level learning**. Multiple activities may be involved in the evidence.
5. Examples of activity and evidence listed under one LO might also serve for a different LO, if suitably evaluated and presented, but a good range of topics and examples will typically be needed across the FL programme as a whole.
6. It is anticipated that most engineers undertaking a programme of further learning to Bachelors' level will need to undertake some private study/investigation/evaluation linked to but beyond their normal day-to-day work, and in addition to the time preparing/presenting the evidence itself.
7. The focus of the evidence should be on the participant's reflection and evaluation about their actions and learning. Enough project information should be included to give context and to help convey the learning well. However, care should be taken to avoid overloading the evidence with more project detail than is needed to show the learning. Reflective statements in a further learning report can provide additional supporting evidence
8. A common error in evidence is to include more factual information about a project than is needed and too little that conveys the Bachelors' level learning of the participant. It is typically more effective to focus on one or two particularly pertinent aspects of a project and treat them in depth. The whole point is to clearly demonstrate to the assessors in the evidence, ideally in the written evidence, that the required further learning has been achieved. The assessors should not have to indirectly deduce or infer the participant's learning from the evidence or from their personal knowledge of the participant.
9. Examples of evidence will often include some form of report in which conclusions are reached after critically analysing the output of a suitable engineering activity e.g. of investigation, feasibility study, design, a monitoring programme, testing, a survey or research, but other forms of evidence are acceptable. **If an interview is part of the evidence used in assessment, a written record of the interview describing that evidence should be retained and be available for audit purposes.**
10. If using abbreviations, a glossary of them should be included in the evidence – particularly important for self-managed programmes where the assessors may be engineers with a different specialism. (A glossary of terms and abbreviations in JBM documents about further learning is available separately.)

JBM Further Learning Programme (IEng) Some Examples. Please note examples are not included for all LO areas.	
Learning Outcome (i) - Science, mathematics and engineering principles (B1) B1. Apply knowledge of mathematics, statistics, natural science and engineering principles to broadly-defined problems. Some of the knowledge will be informed by current developments in the subject of study	
Activity Examples	**Evidence Examples**
Engineering solutions are founded on physical, biological, natural and social sciences. Therefore there is a need to have an understanding of those sciences. You are continuously developing this knowledge formally and informally but there are particular aspects of these sciences that relate to civil engineering and this will depend on the branch of civil engineering you are in. Fundamentally this is about understanding and explaining things. Understanding the science underlying a situation enables better informed judgements. For example, understanding how a material will perform if temporarily over-stressed, such as its non-linear stress/strain performance or it's plasticity/brittleness, enables its limitations to be taken account of. Example activities could include: • Asset surveys • Materials (including geo materials) testing and appraisal • Selection of materials, products and processes that solve a particular problem • Numerical analyses • Exercise using LSS surveying/setting out software • Highway drainage design for a residential housing estate using Microdrainage.	• Design of surveys/data acquisition explaining the issues to be measured and how they were measured, what the measurements meant, measures to help check data validity or to manage errors or anomalies. These include quantitative and qualitative surveys. • Interpretation of soil data • Design of temporary works • Analysis of highway run-off data and design of appropriate drainage • Approval of output by assessor • Continual assessment by line manager

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Learning Outcome - Design (B5)

"Design solutions for broadly-defined problems that meet a combination of societal, user, business and customer needs as appropriate. This will involve consideration of applicable health and safety, diversity, inclusion, cultural, societal, environmental and commercial matters, codes of practice and industry standards"

Define the problem, identifying any constraints including environmental and sustainability limitations; commercial matters, ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards

Activity Examples	Evidence Examples
Engineering activities are generally carried out within an overarching regulatory framework with additional requirements for a specific discipline. Participants are expected to have an awareness of the overall framework with specific knowledge in their own specialism and knowledge of the holistic issues that need to be considered in the development of engineering solutions. Engineering does not take place in a vacuum and in developing a solution it is necessary for the engineer to consider the impacts that a project can have in a wider context. Activities could include: • Application of best practice in the production of healthy buildings • Temporary works design • Production of method statements and short term programmes • Designing a Highway Improvement scheme such as junction re-design or new features • Design of a sustainable urban drainage scheme (SUDS) • Use of CEQUAL (water quality and hydrodynamic model) • Understanding of company accounts and medium term plan • Understanding of market opportunity phase and customer feedback • Participation in public consultation undertaken as part of the formal planning process	• Identify findings in FL report • Options study of various solutions • Calculations and drawings • Approval of output by line manager/assessor • Reflective report based on candidate's experience • Discussion with supervising engineer