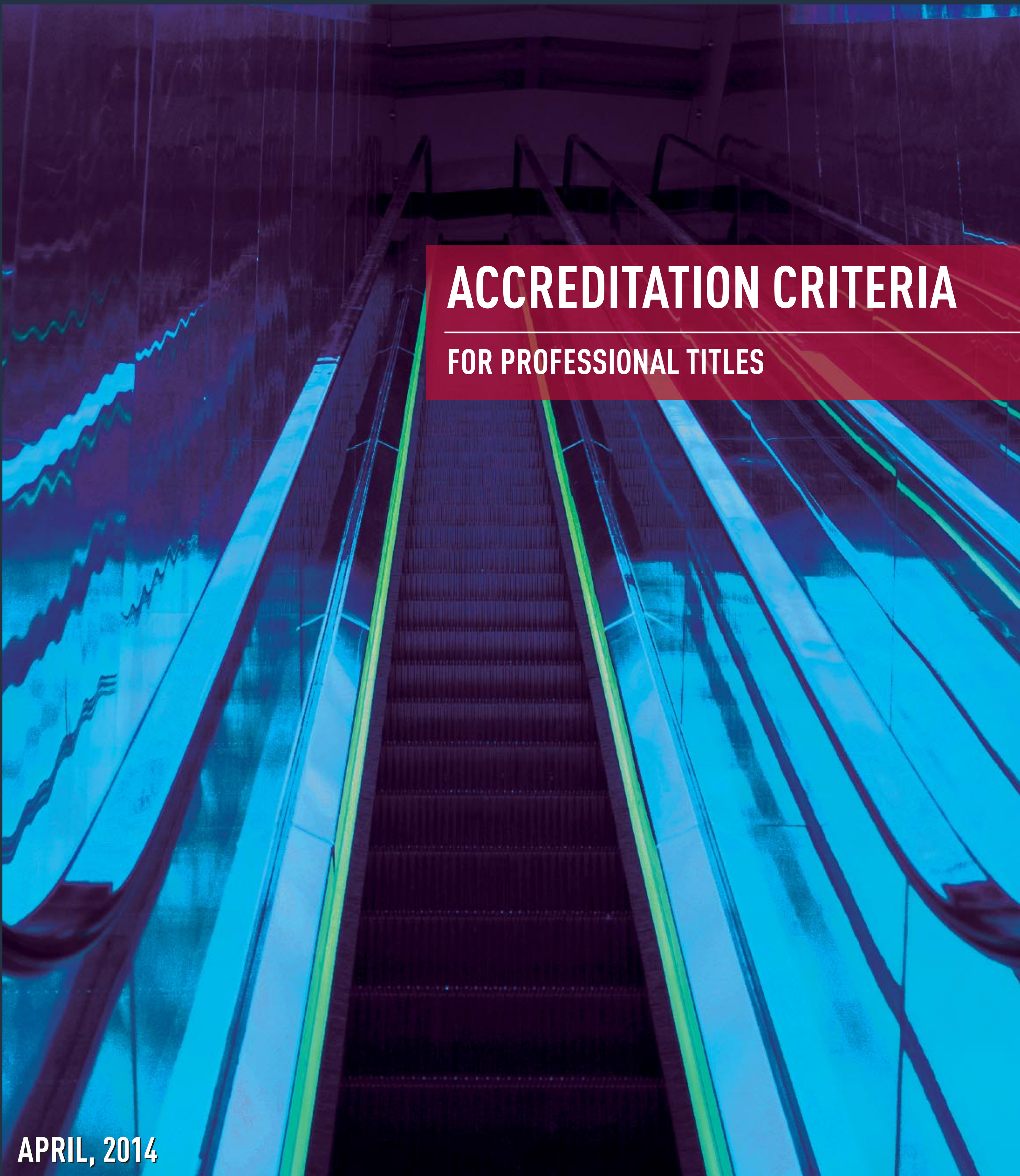
Engineers Ireland



ACCREDITATION CRITERIA

FOR PROFESSIONAL TITLES

APRIL, 2014

www.engineersireland.ie

CONTENTS

Changes from June 2013 version

There have been minor changes to the previous version:

Guidelines on Entry Standards for programmes leading to Associate engineer previously required a Merit Grade 2 in a Higher Certificate in Engineering – the reference to Merit Grade 2 has been removed to reflect current practice.

- Increased level of exploration for Level 8 programmes.
- Guidance notes for programmes from Level 8 to Level 9.

This version is April 2014. As part of our process of continuous improvement there will be ongoing updates. Please check for updates at www.engineersireland.ie

ACCREDITATION CRITERIA

Through the Institution of Civil Engineers of Ireland (Charter Amendment Act, 1969), the Institution has as one of its purposes: setting up and maintaining proper standards of professional and general education and training for admission to membership or to any category of membership of the Institution...... Engineers Ireland, in fulfilment of this purpose, has formally accredited engineering degree programmes in the Republic of Ireland since 1982. The accreditation function of Engineers Ireland is carried out by its Accreditation Board.

Engineering education programmes which satisfy the appropriate criteria laid down in this document are deemed to meet the education standard required of individuals seeking one of the Registered Professional Titles of Chartered Engineer, Associate Engineer and Engineering Technician. Under international agreements such as the Washington, Sydney and Dublin Accords, accreditation decisions of Engineers Ireland are accepted in the signatory countries on the same basis as their "home" graduates. Details of these agreements can be found on our website, www.engineersireland.ie

Holding an accredited engineering qualification represents the first phase of the formation process for achieving registration as an engineering professional. All students on programmes accredited by Engineers Ireland are automatically entitled to become student members of Engineers Ireland. This marks the start of their lasting engagement with Engineers Ireland.

Engineers Ireland is a member of FEANI (The European Federation of National Associations of Engineering). FEANI publishes an Index of Approved Engineering Schools and Courses in its 32 European member countries. Many engineering degree programmes accredited by Engineers Ireland are listed in the Index and accepted in the member countries of FEANI. The guidelines have been modified to reflect accreditation reviews of Engineers Ireland accreditation processes undertaken by the European Network of Accreditation for Engineering Education, which licenses Engineers Ireland to award the EUR ACE label for first and second cycle engineering programmes, and also the International Engineering Alliance, which licences Engineers Ireland to attest that programmes are in accordance with the Washington, Sydney and Dublin Accords. In formulating this fifth edition of its accreditation criteria, Engineers Ireland had regard to the criteria of its international partners and, like them, has based its approach firmly on the basis of programme outcomes.

These include:

- **International Engineering Alliance – Graduate Attributes and Competences (June 2013); and,**
- **EUR-ACE Framework Standards for the Accreditation of Engineering Programmes (November 2008).**

Included in this edition are accreditation criteria for one/two-year Master's degree (level 9) programmes, designed to satisfy the higher education standard for the title of Chartered Engineer for holders of accredited Bachelor's Honours degrees (level 8). Additional descriptive information has been added for some programmes as well as important definitions.

This revision is also mindful of the challenges facing engineering education, consolidation within the third-level sector, and changes in second-level courses and course choices driven by the economic, social and career perceptions of students. These areas will pose challenges to educators who seek to maintain and raise standards.

Engineers Ireland will continue to work closely with the universities and institutes of technology to ensure the maintenance and improvement of the quality of engineering education in Ireland.

> Under international agreements, accreditation decisions of Engineers Ireland are accepted in the signatory countries on the same basis as their "home" graduates.

Damien Owens CEng FIEI
Membership Director & Registrar
April, 2014

DEFINITIONS

At the outset it is important to achieve a common understanding of the terminology used in this document. The following definitions are used, many of which are adopted from the European Qualifications Framework.

Accreditation involves a periodic assessment of a programme of engineering education against accepted standards. It is a peer review process, undertaken by appropriately trained and independent panels of practising engineers, both industrial and academic, on behalf of properly constituted agencies. The process normally involves both scrutiny of data about the programme, and a structured visit to the higher education institution (HEI) running the programme.

The hallmark of a professional engineer is the ability to apply the learning outcomes gained during study to real world situations. These are assessed as working experiences or learned competences. The European Qualifications Framework defines competence as "a demonstrated ability to apply knowledge, skills and attitudes for achieving observable results". Consequently, the related descriptions will embed and integrate knowledge, skills and competence.

- Skill is defined as "ability to carry out managerial or technical tasks". Managerial and technical skills are the components of competences and specify some core abilities which form a competence.
- Competence means in this context the "cognitive and relational capacity" (e.g., analysis capacity, synthesis capacity, flexibility, pragmatism...). If skills are the components, attitudes are the glue that keeps them together.
- Knowledge represents the "set of know-what" (e.g., codes of engineering practice, programming languages, design tools...) and can be described by operational descriptions.

Learning outcomes means statements of what a learner knows, understands and is able to do on completion of a learning process, and are defined in terms of knowledge, skills and competences.

Programme Outcomes are broad statements identifying learning parameters, content and relationships between content areas – what students should learn, understand, or appreciate as a result of their studies by the time they finish a programme or a major.

Knowledge means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual.

The level indicators provided by the National Framework of Qualifications set out the types and depth of knowledge which pertain to each level.

Skills means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy.

> The European Qualifications Framework defines competence as "a demonstrated ability to apply knowledge, skills and attitudes for achieving observable results".

GUIDELINES ON HEI resources (ALL PROGRAMMES)

It is important that irrespective of the level and type of programme being delivered by a Higher Education Institution (HEI), the appropriate governance and quality processes are in place and the HEI can adequately resource the delivery of the programme(s). The following guidelines apply to all programmes.

GOVERNANCE

HEIs should submit engineers programme for accreditation at least every five years. In addition the HEI should submit engineers itself to periodic reviews of its programmes as required by the statutory authorities. Within these reviews, there should be evidence of feedback paths so that issues are addressed in a timely and controlled manner. The issues may cover a broad range (e.g., facilities, student feedback, and external examiners' reports) but there should be clear evidence of consideration and resolution of issues. The addressing or resolution of recommendations arising from previous reviews should be highlighted as part of the accreditation process. The resources within the HEI that manage and maintain the delivery of engineering programmes should be clear, identifiable and unambiguous. The details of processes for programme management should be provided, as well as the context in which this aligns with the overall HEI quality assurance processes. The HEI should demonstrate that the resources to support and deliver the programme will ensure viability of the programme for the duration of the period of accreditation being sought.

BUILDINGS, LABORATORIES AND EQUIPMENT

The buildings, laboratories and equipment should be such as to satisfactorily support the learning process of the student in achieving the programme outcomes. There should be a defined replacement policy for equipment. Staff and students should receive adequate instruction and safety training to a level commensurate with the work being undertaken.

ACADEMIC STAFF

There should be sufficient numbers of academic staff to ensure the effective delivery of the programme outcomes. Staff teaching on engineering degree programmes should:

- be involved in ongoing research work as evidenced by active participation in national and international conferences and publishing in refereed journals;
- be involved with industry by secondment, consulting and ongoing industry-led research;
- generally, have obtained postgraduate research degrees;
- be able to demonstrate their professional competence by having undertaken significant postgraduate work in industry/engineering consultancy and/or research and development – this is normally demonstrated through the acquisition of the Chartered Engineer title; and,
- have the ability to design, develop and implement courses on an accredited engineering degree programme.

GUIDELINES

SUPPORT STAFF

Engineering programmes require substantial inputs from non-engineering personnel in areas such as mathematics, the sciences, business management and other complementary studies. The quality of such staff is as important as that of the engineering staff and the same general standards apply. There should be an adequate number of technical and laboratory staff to ensure that there is a satisfactory level of technical support in workshops and laboratories.

ASSESSMENT OF STUDENT PERFORMANCE (ALL PROGRAMMES)

The pedagogy and method of delivery of programmes is left to the HEIs. Examinations, projects and other assessment instruments should be designed to evaluate the extent to which students can demonstrate achievement of the programme outcomes both throughout the programme and at its conclusion. Good practice demands that all exam papers and assessment procedures should be externally peer evaluated. The emphasis in examinations should be on analysis and problem-solving and not on the recitation of facts or standard solutions. The use of continuous assessment provides the opportunity to assess students' understanding on a more frequent basis. Students should receive timely and frequent feedback to optimise this approach to assessment.

The quality assurance process of the programme provider should seek to ensure that adequacy of standards is achieved in all examinations. The progression rate from semester to semester/ year to year should be reviewed and anomalies identified and addressed. Engineers Ireland is primarily concerned to ensure that programmes for accreditation are designed so that students are enabled to achieve the programme outcomes specified. It does not prescribe the education standard of students entering programmes and the learning process they undertake during a programme as these are, generally, matters best dealt with by programme providers.

However, the experience of Engineers Ireland in the area of accreditation has shown that certain minimum inputs, i.e., entry standards, programme duration and structure have been required in the past if programme outcomes are to be satisfactorily achieved. It is open to providers of programmes to demonstrate that students, regardless of their entrance qualifications, are not disadvantaged in achieving programme outcomes, in particular in the key first year of the engineering programme. HEIs may use tailored introductory modules to support students during the first year of programmes.

It is recognised that for Master's level programmes there may potentially be a greater variety of students entering postgraduate Master's programmes.

These will include holders of accredited primary engineering qualifications, cognate degrees, combinations of qualifications and industrial experience. It is a matter for the academic institution to set the entry requirements, but irrespective of this Engineers Ireland expects achievement of the learning outcomes and that these outcomes should not be diluted to reflect an overly diverse student cohort.

> Examinations, projects and other assessment instruments should be designed to evaluate the extent to which students can demonstrate achievement.

EDUCATION STANDARD REQUIRED FOR THE REGISTRATION OF Engineering Technician

GENERAL OVERVIEW

An Engineering Technician is competent to apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering, or those techniques specially prescribed by professional engineers. He/she works under guidance within their allocated responsibility.

The formation of an Engineering Technician takes a minimum of five years and consists of two phases. The first phase consists of studying and successfully completing an engineering certificate programme approved by Engineers Ireland as meeting the education standard required for the title Engineering Technician.

The second phase is called Initial Professional Development and involves the achievement of the competences necessary to apply basic principles to the solution of technical problems. This phase is described in detail in Engineers Ireland's publication Engineering Technician – Regulations for the title of Engineering Technician.

GUIDELINES ON ENTRY STANDARDS

Engineers Ireland expects the following minimum entry standards for admission to accredited engineering technician programmes:

1. **Higher Certificate (level 6) in Engineering.**
2. **Grade D3 or higher in five Ordinary Level Leaving Certificate subjects including mathematics and English.**
3. **Programme providers may propose alternative entry requirements, which must demonstrate how the programme addresses deficits for students not holding the above entry qualifications.**

GUIDELINES ON PROGRAMME DURATION AND STRUCTURE

Engineers Ireland expects the following programme duration and structure for Engineering Technicians:

- **Higher Certificate (level 6) in Engineering;**
- **two-year '*ab initio*' programme; and,**
- **the student effort required should be such as to merit equivalent to 120 ECTS credits.**

TRANSFER AND MOBILITY

Engineers Ireland is committed to supporting the policies of the National Qualifications Authority of Ireland in respect of facilitating access, transfer and progression for students. Programme providers should have in place procedures and regulations, consistent with maintaining academic standards, to achieve this.

PROGRAMME OUTCOMES

The programme of study should ensure that the graduate demonstrates minimum achievement of the level 6 programme outcomes as set out below.

(a) Knowledge and understanding of the basic mathematics, sciences, engineering sciences and technologies related to the particular branch of engineering.

Graduates should be able to demonstrate knowledge, understanding and the application of, *inter alia:*

(i) basic mathematical and scientific formulae and techniques to solve well-defined engineering problems;

(ii) basic scientific techniques and how they apply to their branch of engineering;

(iii) standard technologies and techniques used in the solution of well-defined engineering problems with particular reference to their advantages and limitations in their branch of engineering.

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(b) The ability to identify, formulate and solve well-defined problems in the particular branch of engineering.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of basic problem-solving techniques;
(ii) the ability to apply an appropriate mathematical/analytical method to a well-defined engineering problem;
(iii) the ability to use industry standard software tools for the solution of well-defined engineering problems.

(c) The ability to contribute to the design of components, systems and processes to meet specified needs.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of the basics of the design process and method;
(ii) the ability to contribute to the design processes within a well-defined sub-domain;
(iii) the ability to use industry-standard design tools and techniques;
(iv) basic knowledge and understanding of codes of practice and industrial standards.

(d) The ability to conduct well-defined investigations to facilitate the solution of problems within the particular branch of engineering.

Graduates should be able to demonstrate, *inter alia:*

(i) the ability to conduct experiments and collate, analyse, present and interpret basic engineering technology data sets;
(ii) the ability to gather basic data from codes of practice, databases and other sources, and to generate data using a range of laboratory and workshop equipment;
(iii) the ability to select and apply appropriate instrumentation and techniques for fault-finding and performance testing.

(e) An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of the importance of the technician's role in society and the need for the highest ethical standards of practice;
(ii) awareness of social and environmental factors during their participation in the design process;
(iii) awareness of common environmental hazards potentially inherent in engineering systems;
(iv) knowledge of the potential health, safety and risk issues of engineering projects.

(f) The ability to work effectively as an individual and in teams, together with the capacity to undertake lifelong learning.

Graduates should be able to demonstrate, *inter alia:*

(i) the ability to undertake Continuing Professional Development to improve their knowledge and competence;
(ii) the ability to work effectively as a member of a team;
(iii) the ability to consult and work with engineers in the realisation of a project;
(iv) knowledge and understanding of the respective functions of technicians, technologists and engineers and how they together constitute the engineering team.

(g) The ability to communicate effectively with the engineering community and with society at large.

Graduates should be able to demonstrate, *inter alia:*

(i) the ability to select and apply appropriate communication tools in order to create deeper understanding, and maximum impact on a given audience;
(ii) the ability to succinctly describe the relevant advantages and disadvantages of their chosen engineering discipline to a lay audience;
(iii) the ability to write technical reports;
(iv) the ability to present a report before a panel.

PROGRAMME DESCRIPTORS

Engineers Ireland has determined that the study of six Programme Areas is necessary if graduates are to achieve the stated Programme Outcomes. The Programme Areas, listed below, are largely coterminous, but occasional overlap may be unavoidable.

- Science and Mathematics
- Discipline-specific Technology
- Software and Information Systems
- Design and Development
- Engineering Practice
- Social and Business Context

Programme Area descriptors outline how each Programme Area, through the Learning Outcomes of its constituent modules, facilitates the engineering graduate's achievement of the stated Programme Outcomes.

Science and Mathematics

This Programme Area should provide students with a basic understanding of the core sciences and engineering sciences, to underpin the dominant engineering technologies in their chosen field. The utility of this scientific material should be liberally demonstrated through the use of case studies and application to well-defined technical problems.

Engineering and science are strongly quantitative, as expressed through the language of mathematics. Engineering technicians need to be numerate to understand the mathematical bases of the core engineering sciences related to their discipline. As with scientific knowledge, mathematical knowledge and skills should be presented in an applied setting. Students should be given ample opportunity to apply a core of standard mathematical techniques to a range of well-defined engineering problems.

Discipline-specific Technology

Technology is commonly perceived in two ways – the sum total of artefacts designed for practical purposes, and the knowledge and skills associated with the structure, function, operation and application of practical artefacts. Engineering technicians have to be competent to apply the basic engineering technologies associated with their chosen discipline. Examples would include: telecommunications, power systems, control systems, manufacturing processes, highway construction and so on.

It is important, therefore, that engineering technician programmes place a primary focus on the understanding and application of core technologies. Students should be aware of the relative environmental impacts of the various technologies.

On the skills side of technology, students should be given ample opportunity to use and apply the latest software/hardware components and systems. The programme should help them develop the necessary analytical skills in laboratories, workshops and projects. Industrial visits, placements and co-operative education schemes offer immense potential for the improvement of the students' technological skills. Students' knowledge of the engineering technologies will be demonstrated in laboratory reports and projects.

Software and Information Systems

Software and information systems are commonly employed throughout the whole field of engineering to facilitate the solution of engineering problems and the communication of knowledge and decisions. Engineering technicians should be able to apply these tools in the field. The mathematics underpinning these systems are often complex; for example, techniques such as structured information retrieval and filtering are in common use today. Engineering technicians should have the ability to use common software and systems tools for the solution of well-defined engineering problems.

Students should be aware of the use of computers for basic quantitative analysis and solution of common engineering problems. Students should also have experience in the application of industry-standard software to engineering problems in their chosen field. They should be shown how to apply, and where necessary, through data exchange, to integrate industry-standard software tools and information systems.

Software and information systems and the electronic encapsulation of knowledge play an important role in the manipulation of, and the communication of, engineering information. Students will therefore require skills in the use of software tools like word processors, presentation packages and spreadsheets for these purposes. They should be introduced to a wide range of computer-based data presentation techniques and should know how to choose the most appropriate one for a particular set of circumstances.

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Design and Development

Engineering technicians make valuable contributions to the design process. They have to implement sub-sets of designs led by technologists and\or Chartered Engineers. This requires, *inter alia*, the development of details within those designs, the execution of front-line tests to generate simple data and to validate basic assumptions used in the designs, the procurement of the necessary equipment and materials, and the participation in the verification of the performance of the resultant artefacts or systems.

It is important, therefore, that engineering technician programmes give due consideration to the basic principles of design and explain the techniques specific to particular engineering products and processes. Students should learn about the various steps from idea to marketplace. Since engineering is primarily concerned with application, the programme should require students to implement simple designs through projects. This could be achieved, advantageously, on a team basis, involving, where possible, students on technology and engineering programmes.

The Engineering Technician has an important role to play in the development of products and processes. Students should therefore have the opportunity to undertake basic performance testing in the laboratory, in the workshop, in particular and where possible, in the field; and further be aware of laboratory simulation. That experience, combined with case studies of similar products, should be used for the refinement, the re-engineering, and the development of simple designs which address well-defined engineering problems.

Engineering Practice

Engineering practice is central to the development of the Engineering Technician. Programmes should explore the industrial environment where graduates are likely to apply their knowledge and skills, including markets, competitors, and basic organisation structures, and be aware of the financial, commercial and environmental constraints faced by industry. The role, and the career opportunities, of Engineering Technicians in these industries should be clarified.

> It is important, therefore, that engineering technician programmes give due consideration to the basic principles of design and explain the techniques specific to particular engineering products and processes.

Engineering success is often the outcome of an evolutionary process based on incremental advances upon earlier experiences. It is essential, therefore, that Engineering Technicians are conversant with the core operational practices of their chosen discipline. Operational practice will include knowledge of manufacturing and basic development processes, quality assurance, project management, methods of control of engineering products and processes, awareness of environmental impacts, operational safety and the elimination of hazards in the workplace.

Students should be made aware of the practical dimension of their work. Various pedagogical approaches can facilitate the development of this awareness, and of the related skills, including case studies, industrial placements, projects, industry speakers, laboratories, workshops and visits to industrial or commercial installations. The mechanisms and benefits of technology transfer between industry and academe should be explained.

Social and Business Context

Engineering is directed to developing, providing and maintaining infrastructure, goods, systems and services for socio-economic benefit. Related education programmes need to develop an awareness of the social, cultural and commercial context of engineering. This includes an understanding of issues related to today's multicultural workforce, of socio-technology and of the constraints on technological developments imposed by health and safety, the environment, codes of practice, politics, the law and financial viability, and the means by which the various risks may be assessed and managed. Students should be made aware of the core methods for the assessment of quality and fitness for purpose of engineering products and systems. They should be given ample opportunity to reflect upon and discuss the ethical consequences of their decisions.

Engineering invariably involves a team approach; it is important, therefore, that students learn how to work with and for others, both within and outside their own disciplines. They should have some knowledge of team dynamics and should be capable of working as a member of a diverse team. Programmes should develop the student's ability to analyse, present and communicate effectively, comprehend the work of others, document their own work, and give and receive clear instructions and impart basic technical information as part of a project team and to a range of external audiences.

Society expects professional behaviour from the engineering profession and therefore, within programmes, students should become familiar with the expectations and standards inherent in professional codes of conduct. Students should learn how to help identify their own learning needs.

The importance of students participating in identifying their own learning needs, and exercising commitment to their own continuing professional development, should be stressed.

EDUCATION STANDARD REQUIRED FOR THE REGISTRATION OF Associate Engineer

GENERAL OVERVIEW

The Associate Engineer (equivalent to an Engineering Technologist in some jurisdictions) is competent to apply in a responsible manner current engineering technologies in a chosen field. They exercise independent technical judgement and work with significant autonomy within their allocated responsibility. The performance of their engineering technology work requires an understanding of relevant engineering, financial, commercial, statutory, safety, management, social and environmental considerations.

GUIDELINES ON ENTRY STANDARDS

The entry standard to an Associate Engineer programme should be such that those holding it have a reasonable prospect of understanding the learning principles presented and of achieving the programme outcomes.

The formation of an Associate Engineer takes a minimum of seven years and consists of two phases.

The first phase consists of studying and successfully completing an engineering technology degree or diploma programme accredited by Engineers Ireland as meeting the education standard required for the title Associate Engineer.

The second phase is called Initial Professional Development and involves the achievement of the competences necessary to apply engineering technology principles to the solution of engineering technology problems. This phase is described in detail in Engineers Ireland's publication Associate Engineer – Regulations for the title of Associate Engineer.

GUIDELINES ON ENTRY STANDARDS

Engineers Ireland expects the following minimum entry standards for admission to approved engineering technology programmes:

1. One year Ordinary degree in Engineering/Engineering Technology (level 7); a Higher Certificate in Engineering approved by Engineers Ireland.
2. *Ab initio* three-year Ordinary degree in Engineering/Engineering Technology (level 7); A grade D3 or better in five Ordinary Level subjects in the Leaving Certificate including mathematics and English.
3. Programme providers may propose alternative entry requirements, which must demonstrate how the programme addresses deficits for students not holding the above entry qualifications.

GUIDELINES ON PROGRAMME DURATION AND STRUCTURE

Engineers Ireland expects the following programme durations and structures for Associate Engineers:

- three- or four-year '*ab initio*' programme;
- one-year programme following a recognised two year Higher Certificate programme; and,
- the student effort required should be equivalent to 180-240 ECTS credits.

TRANSFER AND MOBILITY

Engineers Ireland is committed to supporting the policies of the National Qualifications Authority of Ireland in respect of facilitating access, transfer and progression for students.

Programme providers should have in place procedures and regulations, consistent with maintaining academic standards, to achieve this.

PROGRAMME OUTCOMES

The programme of study should ensure that the graduate demonstrates minimum achievement of the level 7 programme outcomes.

ASSOCIATE ENGINEER

ACCREDITATION CRITERIA

(a) Knowledge and understanding of the mathematics, sciences, engineering technology sciences and technologies related to the particular branch of engineering technology.

Graduates should be able to demonstrate knowledge and understanding of, *inter alia:*

(i) the advantages and limitations of a range of established and relevant mathematical techniques;

(ii) the empirical and theoretical bases of the relevant engineering technology sciences;

(iii) the types and properties of the materials related to their particular branch of engineering technology, including their scientific basis;

(iv) the principles, applications and limitations of the technologies central to their chosen branch of engineering technology;

(b) The ability to identify, formulate and solve broadly-defined problems in the particular branch of engineering technology.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of problem-solving methodology;

(ii) the ability to select and apply an appropriate mathematical/analytical/numerical method to a broadly-defined engineering technology problem;

(iii) the ability to create mathematical models by deriving appropriate equations, and specifying boundary conditions and underlying assumptions and limitations;

(iv) the ability to use and, where necessary, to adapt existing software tools for the solution of broadly-defined engineering technology problems.

(c) The ability to contribute to the design of components, systems and processes to meet specified needs.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of design processes and techniques;

(ii) the ability to apply design processes to broadly-defined engineering problems;

(iii) the ability to use industry-standard design tools and processes;

(iv) knowledge and understanding of codes of practice and industrial standards.

(d) The ability to conduct investigations to facilitate the solution of broadly-defined problems within the particular branch of engineering technology.

Graduates should be able to demonstrate, *inter alia:*

(i) the ability to design and conduct experiments and analyse and interpret data;

(ii) the ability to gather relevant data from codes, data bases and other sources, and to generate data using a range of laboratory and workshop equipment;

(iii) the ability to select and apply appropriate instrumentation and techniques for fault-finding and performance testing;

(iv) the ability, under supervision, to conduct research into broadly-defined issues related to the particular branch of engineering technology.

(e) an understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of the importance of the engineer's role in society and the need for the commitment to the highest ethical standards of practice;

(ii) consideration of social, sustainability and environmental factors during the design process;

(iii) understanding of the scientific basis of the environmental hazards potentially inherent in engineering technology systems;

(iv) knowledge and understanding of the potential health, safety, cultural and risk issues of engineering technology projects, including the relevant legislation.

(f) The ability to work effectively as an individual, in teams and in multidisciplinary settings together with the capacity to undertake lifelong learning.

Graduates should be able to demonstrate, *inter alia:*

(i) the ability to plan and carry through self-directed Continuing Professional Development to improve their knowledge and competence;

(ii) the ability to work effectively as a member of a team;

(iii) the ability to consult and work with experts in various fields in the realisation of a project and know their role within a project team;

(iv) knowledge and understanding of the respective functions of technicians, technologists and engineers and how they together constitute the engineering team;

(v) knowledge of the impact of their work on the costs of a project.

(g) The ability to communicate effectively on broadly-defined engineering activities with the engineering community and with society at large.

Graduates should be able to demonstrate, *inter alia:*

(i) the ability to select and apply appropriate communication tools in order to create deeper understanding, and maximum impact on a given audience;

(ii) the ability to succinctly describe the relevant advantages and disadvantages of their chosen engineering technology to a lay audience;

(iii) the ability to write technical papers and reports, and synthesise their work in abstracts and executive summaries;

(iv) the ability to defend a particular thesis before a panel of peers.

PROGRAMME DESCRIPTORS

Engineers Ireland has determined that the study of six Programme Areas is necessary if graduates are to achieve the stated Programme Outcomes. The Programme Areas, listed below, are largely coterminous, but occasional overlap may be unavoidable.

- Science and Mathematics
- Discipline-specific Technology
- Software and Information Systems
- Design and Development
- Engineering technology Practice
- Social and Business Context

Programme Area descriptors outline how each Programme Area, through the Learning Outcomes of its constituent modules, facilitates the engineering technology graduate's achievement of the stated Programme Outcomes.

Science and Mathematics

This Programme Area should provide students with a good understanding of the basic sciences and engineering sciences, sufficient to underpin adequately the dominant engineering technologies of the chosen field. The utility of this scientific material should be liberally demonstrated through the use of case studies and application to technical problems of increasing complexity. In the latter years of the programme, students should be encouraged to seek out the latest scientific advances, and adapt them, where appropriate, for application to broadly-defined engineering problems.

Engineering and science are strongly quantitative, as expressed through the language of mathematics. Engineering technologists need to be numerate and to understand the mathematical bases of the engineering sciences related to their discipline. As with scientific knowledge, mathematical knowledge and skills should be presented against a background of practical application. Students should be given ample opportunity to apply a range of standard mathematical techniques to a range of engineering problems.

Students should also receive instruction in the mathematical methods for developing, validating, and applying models of engineering technology components and systems in order to achieve optimal design.

Discipline-specific Technology

Technology is commonly perceived in two ways – the sum total of artefacts designed for practical purposes, and the knowledge and skills associated with the structure, function, operation and application of practical artefacts. Associate Engineers have to be competent to apply the engineering technologies central to their chosen discipline. Examples would include: telecommunications, power systems, control systems, algorithms, data structures, manufacturing processes, highway construction and so on.

It is important, therefore, that engineering technology programmes place a primary focus on the understanding and application of known technologies. However, students should be encouraged to seek out new technologies, to understand them, and adapt them, where appropriate, for use in the solution of engineering problems. These should include technologies outside their immediate area of interest. Students should be aware of the relative environmental impacts of the various technologies.

In the skills side of technology, students should be given ample opportunity to use and apply the latest software/hardware components and systems. The programme should help them develop the necessary skills in laboratories, workshops and projects. Industrial visits, placements and co-operative education schemes offer immense potential for the improvement of the students' technological skills. Students' knowledge of the engineering technologies will be demonstrated in design projects, laboratory reports and projects that address well defined problems.

Software and Information Systems

Software and information systems are commonly employed throughout the whole field of engineering to facilitate the solution of engineering problems and the communication of knowledge and decisions. Engineering technology students should be able to apply these tools in the field.

The mathematics underpinning these systems are often complex, for example, techniques such as secure structured information retrieval in local and cloud environments. Whilst engineering technology students will require a basic understanding of the related mathematics, their major strength should lie in the ability to use these systems as tools for the solution of well-defined engineering problems. Students should be exposed to best practice and there should be no reliance on a particular software application.

Students should develop facility in the use of computers for the quantitative analysis, simulation, and solution of engineering problems. Students should also have experience in the application of industry-standard software and numerical analysis packages to engineering problems. They should be shown how to apply, to adapt and, where necessary, through data exchange, to integrate industry-standard software tools and information systems.

Software and information systems and the electronic encapsulation of knowledge play an important role in the manipulation of, and the communication of, engineering information. Students will therefore require skills in the use of software tools like word processors, presentation packages and spreadsheets for these purposes. They should be introduced to a wide range of computer-based data presentation techniques, and should know how to choose the most appropriate one for a particular set of circumstances.

Design and Development

Engineering technologists make valuable contributions to the design process. They have to resolve the practical problems related to the implementation of designs led by Chartered Engineers. This requires, *inter alia*, the development of details within those designs, the execution of tests to generate necessary data and to validate assumptions used in the designs, the procurement of the necessary equipment and materials, and the verification of the performance of the resultant artefacts or systems.

It is important, therefore, that engineering technology programmes give due consideration to the general principles of design, and explain the techniques specific to particular engineering products and processes. Students should learn about the various steps from idea to marketplace, including patents, business planning and technology transfer. Since engineering technology is primarily concerned with application, the programme should require students to carry out designs through both mini and major projects. This could be achieved, advantageously, on a team basis, involving, where possible, students on engineering and engineering technician programmes.

The Associate Engineer has an important role to play in the development of products and processes. Students should therefore have the opportunity to test performance in the laboratory, in the workshop, in the simulation laboratory and in the field (where possible). That experience, combined with case studies of similar products, should be used for the refinement, the re-engineering and the development of particular designs. Students should be encouraged to think beyond the obvious and routine, and be given opportunities to face the challenges of previously unsolved problems.

Engineering Practice

Engineering practice is the *sine qua non* of the engineering technologist. Programmes should explore the industrial environment where graduates are likely to apply their knowledge and skills, including markets, competitors, management structures, and the financial, commercial and environmental constraints faced by industry. The role and the career opportunities of Associate Engineers in these industries should be clarified.

Engineering success is often the outcome of an evolutionary process based on incremental advances upon earlier experiences. It is essential, therefore, that engineering technologists are thoroughly conversant with general engineering practice as well as the particular operational practices of their chosen discipline. Principal amongst these will be operational practices in common use within their discipline, including an awareness of codes of practice and the regulatory framework. Operational practice will include knowledge of manufacturing and development processes, quality assurance, project management, methods of control of engineering products and processes, the assessment and control of environmental impacts, risk management, operational safety and the elimination of hazards in the workplace.

Students should be made aware of the practical dimension of their work. Various pedagogical approaches can facilitate the development of this awareness, and of the related skills, including case studies, industrial placements, projects, industry speakers, laboratories, workshops and visits to industrial or commercial installations. The mechanisms and benefits of technology transfer between industry and academe should be explained.

Social and Business Context

Engineering is directed to developing, providing and maintaining infrastructure, goods, systems and services for industry and the community. Related education programmes need to develop an awareness of the social and commercial context of the engineer's work. This includes an understanding of issues related to today's multicultural workforce, of socio-technology and of the constraints on technological developments imposed by health and safety, the environment, codes of practice, politics, the law and financial viability, and the means by which the various risks may be assessed and managed. Students should be made aware of the various methods for the assessment of quality and fitness for purpose of engineering products and systems and understand how to achieve these attributes in design and development. They should be given ample opportunity to analyse and discuss the ethical consequences of their decisions.

Engineering invariably involves a team approach; it is important, therefore, that students learn how to work with and for others, both within and outside their own disciplines. They should have some knowledge of team dynamics and should be capable of exercising leadership. Programmes should develop the student's ability to analyse, present and communicate technical information as part of a project team and to a range of audiences.

Society expects professional behaviour from its professional engineers and therefore, within programmes, students should become familiar with the expectations and standards inherent in professional codes of conduct. Students should learn how to identify their own learning needs. The importance of students identifying their own learning needs and exercising responsibility for their own continuing professional development should be stressed.

EDUCATION STANDARD REQUIRED FOR THE REGISTRATION OF Chartered Engineer

GENERAL OVERVIEW

The following is the definition of a professional engineer recognised by the Council of Engineers Ireland for the title Chartered Engineer and is the definition adopted in 1960 by the Conference of Engineering Societies of Western Europe and the United States of America (EUSEC):

A Chartered Engineer is competent by virtue of his/her fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He/she is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, design, construction, manufacturing, superintending, managing and in the education of the engineer. His/her work is predominantly intellectual and varied and not of a routine mental or physical character. It requires the exercise of original thought and judgement and the ability to supervise the technical and administrative work of others.

His/her education will have been such as to make him/her capable of closely and continuously following progress in his/her branch of engineering science by consulting newly published works on a worldwide basis, assimilating such information and applying it independently. He/she is thus placed in a position to make contributions to the development of engineering science or its applications.

His/her education and training will have been such that he/she will have acquired a broad and general appreciation of the engineering sciences as well as a thorough insight into the special features of his/her own branch. In due time he/she will be able to give authoritative technical advice and to assume responsibility for the direction of important tasks in his/her branch.

The formation of a Chartered Engineer takes a minimum of eight years and consists of two phases.

The first phase consists of studying and successfully completing an engineering degree programme accredited by Engineers Ireland as meeting the education standard required for the title Chartered Engineer. The second phase is called Initial Professional Development and involves the achievement of the competences necessary to apply engineering principles to the solution of engineering problems. This phase is described in detail in Engineers Ireland's publication Chartered Engineer – Regulations for the title of Chartered Engineer.

GUIDELINES ON ENTRY STANDARDS, PROGRAMME DURATION AND STRUCTURE

Engineers Ireland expects the following minimum entry standards for admission to programmes leading to the educational standard for Chartered Engineer:

Five-year integrated programmes leading to a Master's degree:

1. a grade D3 or better in four Ordinary Level Leaving Certificate subjects plus a grade C3 or better in two Higher Level Leaving Certificate subjects, one of which shall be mathematics;
2. a pass in an approved entrance examination in mathematics is acceptable in lieu of the C3 in Higher Level Mathematics;
3. a pass in a Foundation Course approved by Engineers Ireland; or
4. one or two year Master's programmes leading to a Master's degree. The required entry standard is an accredited level 8 (Bachelor's Honours) engineering degree.

programme providers may propose alternative entry requirements, which must demonstrate how the programme addresses deficits for students not holding the above entry qualifications;

The student effort required should be **equivalent to** 300 ECTS credits.

CHARTERED ENGINEER

ACCREDITATION CRITERIA

Note that graduates holding accredited Ordinary degrees (level 7) in engineering would normally be expected to successfully complete an approved programme of bridging studies before transferring into the latter stages of a five-year Master's degree programme.

TRANSFER AND MOBILITY

Engineers Ireland is committed to supporting the policies of the National Qualifications Authority of Ireland in respect of facilitating access, transfer and progression for students. Programme providers should have in place procedures and regulations, consistent with maintaining academic standards, to achieve this.

PROGRAMME OUTCOMES

The programme of study should ensure that the graduate demonstrates minimum achievement of the level 9 programme outcomes.

(a) Advanced knowledge and understanding of the mathematics, sciences, engineering sciences and technologies underpinning their branch of engineering.

Graduates should have, *inter alia:*

(i) advanced knowledge and understanding of the principles, concepts, limitations and range of applicability of established mathematical tools and methods;

(ii) advanced knowledge and understanding of the theoretical bases and the related assumptions underpinning the engineering sciences relevant to their engineering discipline;

(iii) knowledge and understanding of a wide range of engineering materials, processes and components where relevant to their specialised branch of engineering;

(iv) advanced knowledge and understanding of related developing technologies and how they might impinge upon their branch of engineering.

(b) The ability to identify, formulate, analyse and solve complex engineering problems.

Graduates should, *inter alia*, be able to:

(i) integrate knowledge, handle complexity and formulate judgements with incomplete or limited information;

(ii) create models by deriving appropriate equations and by specifying boundary conditions and underlying assumptions and limitations;

(iii) identify and use appropriate mathematical methods for application to new and ill-defined engineering problems;

(iv) identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques;

(v) apply and where necessary adapt software tools and quantitative methods to solve complex engineering problems.

(c) The ability to perform the detailed design of a novel system, component or process using analysis and interpretation of relevant data.

Graduates should have, *inter alia:*

(i) knowledge and understanding of design processes and techniques and the ability to apply them in unfamiliar situations;

(ii) the ability to apply design methods to unfamiliar, ill-defined problems, possibly involving other disciplines;

(iii) the ability to investigate and define a need and identify constraints including environmental and sustainability limitations, health, safety and risk assessment issues;

(iv) knowledge and understanding of codes of practice and industry standards including: the need for their application, the limits of their applicability and how to proceed in the absence of codes and standards;

(v) the ability to redesign existing products, processes or systems or develop novel products, processes or systems in order to improve productivity, quality, safety and other desired features.

(d) The ability to design and conduct experiments and to apply a range of standard and specialised research (or equivalent) tools and techniques of enquiry.

Graduates should, *inter alia*, be able to:

(i) extract, through literature search or experiment, information pertinent to an unfamiliar problem;

(ii) design and conduct experiments and to analyse and interpret data;

(iii) critically evaluate current problems and new insights at the forefront of the particular branch of engineering;

(iv) incorporate aspects of engineering outside their own discipline and consult and work with experts in other fields;

(v) contribute to the development of scientific/technological knowledge in one or more areas of their engineering discipline.

(e) An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

Graduates should have, *inter alia:*

(i) the ability to reflect on social and ethical responsibilities linked to the application of their knowledge and judgements;

(ii) knowledge and understanding of the social, environmental, ethical, economic, financial, institutional, sustainability and commercial considerations affecting the exercise of their engineering discipline;

(iii) knowledge and understanding of the health, safety, cultural and legal issues and responsibilities of engineering practice, and the impact of engineering solutions in a societal and environmental context;

(iv) knowledge and understanding of the importance of the engineer's role in society and the need for the commitment to highest ethical standards of practice;

(v) knowledge, understanding and commitment to the framework of relevant legal requirements governing engineering activities, including personnel, environmental, health, safety and risk issues.

(f) The ability to work effectively as an individual, in teams and in multidisciplinary settings, together with the capacity to undertake lifelong learning.

Graduates should have, *inter alia:*

(i) the ability to recognise and make use of the interactions between the engineering technologies and the technologies associated with other disciplines and professions;

(ii) the ability to lead, to consult and to work with experts in various fields in the realisation of a product or system;

(iii) knowledge and understanding of the respective functions of technicians, technologists and engineers and how they together constitute the engineering team or project team;

(iv) knowledge and understanding of group dynamics and ability to exercise leadership in project teams;

(v) the ability to plan and carry through self-directed Continuing Professional Development to improve their own knowledge and competence;

(vi) knowledge and understanding of concepts from a range of areas outside engineering;

(vii) knowledge of the impact of their work on the costs of a project.

(g) the ability to communicate effectively on complex engineering activities with the engineering community and with society at large.

Graduates should be able to, *inter alia:*

(i) select and apply appropriate communication tools in order to create deeper understanding and maximum impact on a given audience;

(ii) succinctly describe the relevant advantages and disadvantages of the various technologies to a lay audience;

(iii) communicate effectively in public, national, international and multicultural contexts;

(iv) write technical papers and reports, and synthesise their own work and that of others in abstracts and executive summaries;

PROGRAMME AREA DESCRIPTORS

Engineers Ireland has determined that the study of six Programme Areas is necessary if graduates are to achieve the Programme Outcomes described in the sections that follow. Programme Area descriptors outline how each Programme Area, through the learning outcomes of its constituent modules, can contribute to the achievement of the Programme Outcomes by the engineering student. Programme Areas are largely mutually exclusive; though overlap is unavoidable, it is also recognised that in some instances these mutually reinforce each other. The Programme Areas Descriptors are:

- Sciences and Mathematics
- Discipline-specific Technology
- Software and Information Systems
- Creativity and Innovation
- Engineering Practice
- Social and Business Context

Sciences and Mathematics

The study of the sciences provides the basic intellectual tools which engineers use to understand and harness the forces of the world. Students need to develop a good understanding of the sciences in general and, depending on their chosen discipline, they will study specific sciences in greater depth. This understanding forms the basis on which the engineering sciences of their chosen discipline will be further developed, sometimes to the boundaries of the field, within their programme of study. Students should be encouraged to reflect upon standard theories, and their inherent assumptions, and, where necessary, adapt them to a range of complex and ill-defined problems. Engineering and science are strongly quantitative, as expressed through the language of mathematics. Engineers need to be numerate and well versed in the mathematical methods required to understand and apply the underlying sciences of their discipline. Engineers therefore also need the mathematical tools to allow them to develop, validate, apply and adapt models of engineering components and systems in order to achieve optimal design.

Discipline-specific Technology

Technology is commonly perceived in two ways – the sum total of artefacts designed for practical purposes, and the knowledge and skills associated with the structure, function, operation and application of practical artefacts. Engineers use science and technology (in both these forms) to create products and systems which themselves often constitute new technologies. It is important therefore that graduate engineers are thoroughly versed in the engineering technologies relevant to their chosen discipline. Examples would include telecommunications, power systems, control systems, algorithms, data structures, manufacturing processes, construction methods, etc. Students should also have the opportunity to become involved in multidisciplinary projects which require them to draw upon technologies outside their immediate area of interest. On the skills side of technology, students will need to be able to work with the latest software applications/hardware platforms, and to develop the related skills in the laboratory, workshop and project implementation.

Software and Information Systems

Software and information systems are used throughout the whole field of engineering to facilitate the solution of engineering problems and the communication of engineering decisions.

ACCREDITATION CRITERIA

The solution of engineering problems is facilitated by techniques such as structured information retrieval and filtering, simulation, and quantitative analysis. Engineering students should therefore be taught the theory underlying those software and information systems which are of particular significance to engineering practice. The teaching of these topics will rely heavily on the students' knowledge of the relevant mathematical techniques. Students will also require instruction in the skills of using computers for the quantitative analysis, simulation, and solution of engineering problems. They should know how to apply, to adapt and, where necessary, through data exchange, to integrate industry–standard software tools and information systems.

Software, information systems and the electronic encapsulation of knowledge play an important role in the manipulation and communication of engineering information. Students will therefore require skills in the use of software tools for these purposes. They should be familiar with a wide range of computer-based data presentation techniques and should learn how to choose the most appropriate one for a particular set of circumstances.

Creativity and Innovation

Research and design are central components of creativity and innovation. Research seeks to generate new knowledge which may lead, through the design process, to new products and systems. This Programme Area should facilitate students' understanding of the experimental method and how its application can lead to new knowledge and insights in an organised way. Students should be familiar with a range of standard and specialised research tools and techniques of inquiry and should be provided opportunities to draw up and execute, independently, a research plan.

Design is at the heart of engineering. Design studies should include consideration of the design process and of techniques specific to particular engineering products and processes as applied to the resolution of complex problems. Students should be encouraged to think beyond the obvious and routine, and be given opportunities to face the challenges of previously unsolved problems. For example, consideration should be given to including in the programme, the art of problem solving, heuristics, theory of inventive problem solving (TRIZ), etc. By these means, a student's ability to contribute to the creative process should be developed.

Since engineering is ultimately about practical activities, such innovation should include the practical testing of ideas in the laboratory and conducting research for information to develop these ideas further. These activities should be linked to technical analysis and the critical evaluation of results. Also related to practical issues, students should explore the various steps from idea formulation to marketplace, including patents, business planning and technology transfer. In both research and design, students should have the opportunity to be involved in multidisciplinary projects.

Engineering Practice

The success of new engineering developments is often closely related to earlier experience. Students need to be familiar with general engineering practice and with the particular operational practices of their discipline. Related to this is responding to real life situations and day-to-day management of complex engineering projects – supervising others, dealing with technical uncertainty and having awareness of codes of practice and the regulatory framework. Operational practice will develop students' knowledge of manufacturing or development processes, methods of control of engineering products and processes, the assessment of hazards and operational safety.

Students should be made aware of the practical dimension of their work. Various pedagogical approaches can facilitate the development of this awareness, including case studies, industrial placements, projects, industry speakers, laboratories, workshops and visits to industrial or commercial installations.

Social and Business Context

Engineering is directed to developing, providing and maintaining infrastructure, goods, systems and services for industry and the community. Programmes need to develop an awareness of the social and commercial context of the engineer's work. This includes an understanding of issues relating to today's multicultural workforce, of socio-technology, and of the constraints on technological developments imposed by health and safety, the environment, codes of practice, politics, the law and financial viability, management issues and the means by which the various risks may be assessed and managed. The commercial implications of engineering decisions and their impact on design and implementation should be addressed. Students should be made aware of the various methods for the assessment of quality and fitness for purpose of engineering products and systems, and understand how to achieve these attributes in design and development. They should be given ample opportunity to analyse and discuss the ethical consequences of their decisions.

Engineering invariably involves a team approach; it is important therefore that students learn how to work with and for others, both within and outside their own disciplines. They should have some knowledge of team dynamics, and should be capable of exercising leadership. Programmes should develop the student's ability to analyse, present and communicate technical information to a range of audiences.

Society expects professional behaviour from its professional engineers and therefore programmes should enable students to become familiar with the expectations and standards inherent in professional codes of conduct. Engineers need to undertake comparative evaluation of financial and economic factors within the contextual framework of their work and compliance with legal, health and safety criteria.

The importance of students identifying their own learning needs, and exercising responsibility for their own continuing professional development, should be stressed.

Additional Guidance

Master's degrees accredited for the purposes of registration as a Chartered Engineer vary in nature and purpose. Some programmes offer the opportunity to study a subject area in greater depth, particular aspects or applications of a broader discipline in which the graduate holds an accredited honours engineering degree. Others bring together different engineering disciplines or sub-disciplines in the study of a particular topic, or engineering application, while a further category may be truly multidisciplinary. Master's programmes also provide an opportunity to integrate the technical and non-technical aspects of engineering, and to develop a commitment to professional and social responsibility and ethical codes.

The key factor in considering Master's degrees for accreditation is that they deliver the programme outcomes, which should be interpreted in the context of the particular discipline. The outcomes are designed to enable development and innovation of new programmes.

Graduates from an accredited Master's degree programme will have the general and specific programme outcomes acquired as part of a level 8 Bachelor's honours qualification accredited by Engineers Ireland and will have some of these to enhanced and extended levels as a result of undertaking the advanced programme.

In particular, they will need to demonstrate the ability to integrate their prior knowledge and understanding of the discipline and engineering practice with the development of advanced level knowledge and understanding, to solve a substantial range of complex engineering problems in multidisciplinary settings. They will have acquired much of this ability through individual and/or group projects. Ideally some of these projects would have included industrial involvement or be practice based.

The range of general learning outcomes described for graduates from honours Bachelor's degree programmes will also apply to graduates from Master's degree programmes. In respect of general transferable skills, the following enhanced outcomes should be expected of Master's degree graduates:

- the ability to develop, monitor and update project plans to reflect a changing operating environment;
- the ability to monitor and adjust a personal programme of work on an ongoing basis, and to learn independently;
- the ability to exercise initiative and personal responsibility, which may be as a team member or leader; and,
- the ability to learn new theories, concepts, methods, etc., and apply these in unfamiliar situations.

EDUCATIONAL STANDARDS FOR BACHELORS HONOURS (LEVEL 8) PROGRAMMES

Graduates holding Bachelor's (Honours) accredited qualifications awarded prior to 2013 meet the educational standard for Chartered Engineer. From 2013 a Master's level qualification is required to meet the educational standard. Many HEIs continue to deliver Bachelor's level 8 qualifications and many of these programmes continue to be accredited as they provide the bulk of the learning outcomes to meet the new requirements. Students can specialise by taking a Master's programme in an area that is of particular interest to them. The programme outcomes for level 8 programmes are set out below and should be considered as a subset of the programme area descriptors used for level 9 programmes.

GUIDELINES ON PROGRAMME DURATION AND STRUCTURE

Engineers Ireland expects the following minimum entry standards for admission to programmes leading to the award of Bachelor's Honours degree in engineering:

1. **A grade D3 or better in four Ordinary Level Leaving Certificate subjects plus a grade C3 or better in two Higher Level Leaving Certificate subjects, one of which shall be mathematics.**
2. **A pass in an approved entrance examination in mathematics is acceptable in lieu of the C3 in Higher Level Mathematics.**
3. **A pass in a Foundation Course approved by Engineers Ireland.**
4. **Programme providers may propose alternative entry requirements, which must demonstrate how the programme addresses deficits for students not holding the above entry qualifications.**

The student effort required should be equivalent to 240 ECTS credits. Note that graduates holding accredited Ordinary degrees (level 7) in engineering would normally be expected to successfully complete an approved programme of bridging studies before transferring into the latter stages of a four-year degree programme.

TRANSFER AND MOBILITY

Engineers Ireland is committed to supporting the policies of the National Qualifications Authority of Ireland in respect of facilitating access, transfer and progression for students. Programme providers should have in place procedures and regulations, consistent with maintaining academic standards, to achieve this.

PROGRAMME OUTCOMES

(a) Knowledge and understanding of the mathematics, sciences, engineering sciences and technologies underpinning their branch of engineering.

Graduates should be able to demonstrate, *inter alia:*

(i) knowledge and understanding of the principles, concepts, limitations and range of applicability of established mathematical tools and methods;
(ii) knowledge and understanding of the theoretical bases and the related assumptions underpinning the engineering sciences relevant to their engineering discipline;
(iii) knowledge and understanding of a range of engineering materials, processes and components relevant to their branch of engineering;
(iv) knowledge and understanding of related developing technologies and how they might impinge upon their branch of engineering.

(b) The ability to identify, formulate, analyse and solve engineering problems;

Graduates should, *inter alia*, be able to:

(i) integrate knowledge and understanding, and formulate judgements in one or more specialised areas, some of it at the current boundary of the field;
(ii) create models by deriving appropriate equations and by specifying boundary conditions and underlying assumptions and limitations;
(iii) identify and use appropriate mathematical methods for application to engineering problems;
(iv) identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques;
(v) apply and, where necessary, adapt software tools and quantitative methods to solve engineering problems.

(c) The ability to design a system, component or process to meet specified needs.

Graduates should have, *inter alia:*

(i) knowledge and understanding of design processes and techniques, and the ability to apply them in familiar situations;
(ii) the ability to apply design methods to unfamiliar, problems;
(iii)the ability to investigate and define a need and identify constraints including environmental and sustainability limitations, health, safety and risk assessment issues;
(iv) knowledge and understanding of codes of practice and industry standards and the need for their application;
(v) the ability to redesign existing products, processes or systems in order to improve productivity, quality, safety and other desired features.

(d) The ability to design and conduct experiments and to conduct guided research, or advanced technical activity.

Graduates should, *inter alia*, be able to:
(i) extract, through literature search or experiment, information pertinent to an unfamiliar problem that is within the current boundaries of the field;
(ii) design and conduct experiments and, under guidance in a peer or team relationship, to analyse and interpret data;
(iii) critically evaluate problems within the boundaries of knowledge in the particular branch of engineering;
(iv) incorporate aspects of engineering outside their own discipline, and consult and work with experts in other fields.

(e) An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

Graduates should have, *inter alia:*
(i) the ability to reflect on social and ethical responsibilities linked to the application of their knowledge and judgements;
(ii) knowledge and understanding of the social, environmental, ethical, economic, financial, institutional, sustainability and commercial considerations affecting the exercise of their engineering discipline;
(iii) knowledge and understanding of the health, safety, cultural and legal issues and responsibilities of engineering practice, and the impact of engineering solutions in a societal and environmental context;
(iv) knowledge and understanding of the importance of the engineer's role in society and the need for the commitment to highest ethical standards of practice;
(v) knowledge, understanding and commitment to the framework of relevant legal requirements governing engineering activities, including personnel, environmental, health, safety and risk issues.

(f) The ability to work effectively as an individual, in teams and in multidisciplinary settings, together with the capacity to undertake lifelong learning.

Graduates should be able to demonstrate, *inter alia:*
(i) the ability to recognise and make use of the interactions between the engineering technologies and the technologies associated with other disciplines and professions;
(ii) the ability to consult and to work in engineering teams in the realisation of a product or system;
(iii) knowledge and understanding of the respective functions of technicians, technologists and engineers, and how they together constitute the engineering team or project team;
(iv) knowledge and understanding of group dynamics and ability to exercise leadership in project teams;
(v) the ability to plan and carry through self-directed Continuing Professional Development to improve their own knowledge and competence;
(vi) knowledge and understanding of concepts from selected areas outside engineering;
(vii) knowledge of the impact of their work on the costs of a project.

(g) The ability to communicate effectively on specialised engineering activities with the engineering community and with society at large.

Graduates should be able to, *inter alia:*
(i) select and apply appropriate communication tools in order to create deeper understanding and maximum impact on a given audience;
(ii) succinctly describe the relevant advantages and disadvantages of their own and related engineering technologies to a lay audience;
(iii) communicate effectively in public and national and international contexts;
(iv) write technical papers and reports, and synthesise their own and their team's work in abstracts and executive summaries;
(v) communicate effectively on specialised engineering activities and be able to give and receive clear instructions.

CHARTERED ENGINEER

ACCREDITATION CRITERIA

PROGRAMME OUTCOMES – LEVEL 8 TO 9

The Programme Outcomes below represent the additional outcomes to be achieved in addition to the outcomes of an accredited Bachelor's Honours (level 8) engineering degree.

a) Advanced knowledge and understanding of the mathematics, sciences, engineering sciences and technologies underpinning their branch of engineering.

Graduates should be able to demonstrate, *inter alia:*

(i) same as level 9;
(ii) same as level 9;
(iii) knowledge and understanding of a range of engineering materials, processes and components where relevant to their specialised branch of engineering;
(iv) same as level 9.

(b) The ability to identify, formulate, analyse and solve complex engineering problems.

Graduates should, *inter alia*, be able to:

(i) integrate knowledge, handle complexity and formulate judgements with incomplete or limited information;
(ii) same as level 9;
(iii) identify and use appropriate mathematical methods for application to new and ill-defined engineering problems;
(iv) same as level 9;
(v) apply and, where necessary, adapt software tools and quantitative methods to solve complex engineering problems.

(c) The ability to perform the detailed design of a novel system, component or process using analysis and interpretation of relevant data.

Graduates should have, *inter alia:*

(i) same as level 9;
(ii) same as level 9;
(iii) same as level 9;
(iv) same as level 9;
(v) same as level 9.

(d) The ability to design and conduct experiments and to apply a range of standard and specialised research (or equivalent) tools and techniques of enquiry.

Graduates should, *inter alia*, be able to:

(i) same as level 9;
(ii) same as level 9;
(iii) same as level 9;
(iv) same as level 9;
(v) same as level 9.

(e) An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.

Graduates should have, *inter alia:*

The development of this outcome should reflect the additional in-depth application necessary when dealing with decision-making for complex or advanced problems at level 9.

(i) same as level 9;
(ii) same as level 9;
(iii) same as level 9;
(iv) same as level 9;
(v) same as level 9.

(f) The ability to work effectively as an individual, in teams and in multidisciplinary settings, together with the capacity to undertake lifelong learning.

Graduates should have, *inter alia:*

(i) same as level 9;
(ii) ability to lead, to consult and to work with experts in various fields in the realisation of a product or system;
(iii) same as level 9;
(iv) same as level 9;
(v) same as level 9;
(vi) same as level 9;
(vii) same as level 9.

(g) the ability to communicate effectively on complex engineering activities with the engineering community and with society at large.

Graduates should be able to, *inter alia:*

(i) same as level 9;
(ii) same as level 9;
(iii) same as level 9;
(iv) same as level 9.

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