Requirements for Initial Academic Education for Engineering Technologists

Section A: Introduction

1 Requirements for Graduate Membership of IPENZ

The New Zealand academic qualifications recognised by IPENZ for normal entry into the class of Technical Member (TIPENZ) and Engineering Technology Practitioner (ETPract) registration in New Zealand are those awarded to students after completing an IPENZ-accredited Bachelor of Engineering Technology degree of not less than three years of full-time study at tertiary level. IPENZ accords accreditation to programmes which, after careful assessment, are deemed to meet the standard required by IPENZ. This standard is internationally benchmarked through the Sydney Accord[2]. Graduates from such programmes are eligible, on application, for Graduate membership of IPENZ (GIPENZ).

2 Aims and Objectives of Accreditation

The main aim of accreditation is to identify and accredit those engineering technology degree programmes *that meet the standard recognised through the Sydney Accord*. These degrees need to have as a principal aim, to develop intellectual independence in graduates, and to comply with the legal definition of a degree in New Zealand and provide graduates with the generic attributes substantially equivalent to the IPENZ Graduate Competence Profile for Engineering Technologists http://www.ipenz.org.nz/ipenz/Education_Career/accreditation/Graduate_Competency_Profiles_Nov_2009.pdf The graduate capabilities described in the IPENZ Graduate Profile are benchmarked to the exemplar graduate attributes of qualifications recognised under the Sydney Accord http://www.ieagreements.com/IEA-Grad-Attr-Prof-Competencies-v2.pdf

More specifically, accreditation:

- publically identifies programmes that have been evaluated by IPENZ, independently of the tertiary education provider offering the programme, as having met the criteria set out in this document
- provides a statement of the standing of accredited programmes that tertiary education providers can offer to prospective students
- provides a basis for international comparability and graduate mobility
- provides a statement to governments and tertiary education providers of the basic requirements of a professional engineering education and the resources reasonably required to meet these requirements

[2] IPENZ is a signatory to the Sydney Accord which is an agreement between engineering bodies in Canada, Australia, UK, Ireland, South Africa, Hong Kong-China and New Zealand that each would recognise qualifications accredited by each signatory as meeting the academic requirements for engineering technologist membership/registration of their respective engineering bodies.

- allows consultative feedback on the design of new programmes and modes of delivery, and assistance in the promotion of innovation and good educational practice.

3. Glossary of Terms[3]

Programme of Study/Programme
The qualification for which accreditation is being sought, which must be differentiated from un-accredited programmes on the graduation certificate.

Assessment Tasks
Assessment activities that contribute to the overall grade for a Course.

Basic Sciences
Fundamental knowledge about nature and its phenomena.

Branch of Engineering
A generally-recognised, major subdivision of engineering such as the traditional disciplines of Chemical, Civil, or Electrical Engineering, or a cross-disciplinary field of comparable breadth including combinations of engineering fields, for example Mechatronics, and the application of engineering in other fields, for example Bio-Medical Engineering.

Broadly-defined engineering problems
Engineering problems which cannot be resolved without knowledge of technological principles and physical processes and have some or all of the following characteristics:

- involve a variety of factors which may impose conflicting constraints
- can be solved by application of well-proven analysis techniques
- requires knowledge of principles and applied procedures or methodologies
- belong to families of familiar problems which are solved in well-accepted ways
- may be partially outside those encompassed by standards or codes of practice
- involve several groups of stakeholders with differing and occasionally conflicting needs
- have consequences which are important locally, but may extend more widely
- are parts of, or systems within complex engineering problems)

Consistent Assessment
Assessments that achieve reliable or repeatable outcomes.

Course
An individual course or paper that forms part of an accredited programme.

Engineering Fundamentals
A systematic formulation of engineering concepts and principles based on mathematical and basic sciences to support applications.

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[3] This glossary of terms has been adopted by IPENZ on an interim basis pending the outcome of reviews currently being undertaken through the International Engineering Alliance and the European Federation of National Engineering Associations (FEANI)

Engineering
Engineering is characterised by the presence of most or all of the following things:

- Engineering is purposeful – it seeks to use knowledge and resources to make interventions in the natural world that meet a present or future need of people

- Engineering is creative – it involves creativity to develop or design new or improve existing artefacts, products, processes and services
- Engineering seeks efficiency – it is concerned with the wise use of resources
- Engineering is predictive of the outcomes it seeks to achieve – it seeks to use mechanistic understanding of both natural and man-induced processes to develop models, that allow reliable predictions to be made of the future performance of any artefact, product, process, system or service to be made
- Engineering uses available materials, systems and resources – it uses understanding of the properties of materials, systems and resources to ensure that artefacts, products, processes, systems or services that are created are of sufficient durability that their use can continue for suitable periods of time
- Engineering includes risk management – it recognises limitations imposed by incomplete knowledge or understanding of systems, materials and processes and develops means to control or manage the resultant risks to levels acceptable to society at large

Engineering School
The operational unit within a tertiary education provider that is responsible for managing an accredited engineering programme.

Engineering Sciences
Include engineering fundamentals that have roots in the mathematical and physical sciences, and where applicable, in other natural sciences, but extend knowledge and develop models and methods in order to lead to applications and solve problems, providing the knowledge base for engineering specializations.

Engineering Specialisation
A generally-recognised subdivision within a branch of engineering, for example Structural and Geotechnical Engineering within Civil Engineering; the extension of engineering fundamentals to create more specialised theoretical frameworks and bodies of knowledge.

Faculty
Academic staff involved in the delivery of an accredited engineering programme.

Mathematical Sciences: mathematics, numerical analysis, statistics and aspects of computer science cast in an appropriate mathematical formalism.

Natural Sciences
Provide, as applicable in each engineering discipline or practice area, an understanding of the physical world including physics, mechanics, chemistry, earth sciences and the biological sciences,

Professional Development

The systematic, accountable maintenance, improvement and broadening of knowledge and skills, and the development of personal qualities necessary for the execution of professional and technical duties throughout an engineering practitioner's career.

Engineering Technologists
Engineering Technologists apply analytical skills and knowledge of technological principles and physical processes to solve broadly defined engineering problems.

Programme Leader
The staff member with overall academic responsibility for a programme.

Project
A course or collection of courses which lead to a significant design output and/or engineering artefact that demonstrates the students ability to integrate their knowledge and skills to the practical resolution of a complex engineering problem.

Research
In essence, research in engineering is research to improve the practice of engineering – it gives engineers better ways to do their job.

Engineering research seeks to advance the practice of engineering by means such as:

- Discovery of new materials, theoretical models and processes which can enhance the performance, quality, efficiency, cost effectiveness and life of engineering systems
- Increasing the quality of models by which predictions are made, thereby improving process understanding
- Investigating and defining the properties of new or existing materials, systems and resources so that their use can be more appropriate and reliable to the end-user
- Developing improved design methodologies so that the resultant outcome is more efficient or reliable, or poses less risk to its end-users
- Improving control and risk management frameworks around particular families of engineering problems

Substantial Equivalence
Applied to educational programmes means that two programmes, while not meeting a single set of criteria, are both acceptable as preparing their respective graduates to enter formative development toward registration.

Targeted Graduate Outcomes
The skills and knowledge the tertiary institution is seeking to develop in graduates from a programme

Valid Assessment
Assessments that measure what they are intended to measure (the achievement of targeted graduate outcomes).

3 Diversity of Engineering Technology Degree Programmes

IPENZ, by embracing all fields of engineering, recognises that its members work as engineers in a diverse range of work roles and industries. IPENZ accreditation criteria, therefore, are not intended to restrict degrees to the traditional disciplines of engineering. Other disciplines and technologies may be recognised by IPENZ but this does not imply approval of either shallow or narrow specialisation.

Nationally the range of programmes offered should provide for increasing flexibility of occupational opportunity; recognise both the ever-widening range of engineering applications and the value of an engineering education in other walks of life. Some programmes may emphasise technical specialisation in a particular engineering field; some may provide a broader technical exposure, drawing on several engineering disciplines; and some may emphasise management themes while maintaining an engineering and science core. All should develop the ability to engage with broad technical issues at an advanced level and in a real-world context.

4 Overview of Accreditation Criteria

IPENZ has adopted three fundamental parts to the accreditation criteria:

Part 1: The programme and programme outcomes

1. Graduate outcomes
2. The curriculum
3. Admission standards
4. Assessment

Part 2: Institutional Infrastructure, Staffing and Culture

5. Academic staff
6. Technical staff
7. Laboratories
8. Independent study facilities
9. Educational and professional culture

Part 3: Management structures and quality systems to sustain and enhance the programme and its delivery

10. Management structure
11. Institutional support
12. Advisory structures
13. Quality processes

5 Accreditation Process

The accreditation process is defined separately in the IPENZ Manual for the Accreditation of Professional Engineering and Engineering Technology Programmes
www.ipenz.org.nz/IPENZ/Forms/pdfs/Accreditation-Manual-5th-Edition-November-06.pdf .

Section B: Accreditation Criteria for Engineering Technology Degree Programmes

Part 1: The Programme and Programme Outcomes

1 Graduate Outcomes

> **Comment**
> The IPENZ accreditation process is primarily concerned with graduate outcomes – the attributes demonstrated by graduates. Providers are expected to supply sufficient evidence that their engineering programmes produce graduates with attributes that reflect the IPENZ Graduate Competence Profile for Engineering Technologists; the specific technical requirements of the particular field of engineering specialisation; and any special characteristics of the provider or its industry stakeholders.

The provider is required to produce evidence of:

1.1 a clear statement of targeted graduate outcomes for the programme that reflect:

- substantial equivalence to the generic IPENZ Graduate Competence Profile for Engineering Technologists http://www.ipenz.org.nz/ipenz/Education_Career/accreditation/Graduate_Competency_Profiles_Nov_2009.pdf
  - specific technical requirements of the particular field of engineering specialisation
  - any special characteristics of the provider
  - feedback from formal industry advisory mechanisms
  - any other specific stakeholder requirements
  - national and international benchmarks

1.2 how individual courses contribute to the development of targeted graduate outcomes

1.3 systematic development and assessment of these targeted graduate outcomes throughout the programme

2 The Curriculum

> ***Comment***
> *The initial tertiary education of an engineering technologist should provide an in-depth core of applied engineering knowledge and skills appropriate to an engineering discipline. Subjects should be studied formally, in an ordered programme conducted within a tertiary institution. When courses are shared between programmes the academic entry requirements, and the expected graduate competency profiles, need to be taken into account.*

2.1 Technical Foundations

> ***Comment***
> *A strong grounding in mathematics, the sciences and engineering fundamentals is the foundation for education of an engineering technologist.*

Mathematics as an identifiable component should be taught in the early stages of the programme. It should be applications-based and illustrate the importance of mathematics as a tool for identifying and solving problems. Mathematics should not dominate the course but its importance should not be overlooked.

The provider is required to demonstrate that the curriculum includes:

- mathematics and sciences necessary for the study of applied engineering practice;
- a systematic introduction to the coherent body of knowledge and skills related to a particular field of engineering, including examples of current codes of practice;
- an integrated exposure to current and emerging technologies and their applications;
- hand-on exposure to the practical engineering skills and techniques applicable to the student's particular branch of engineering.

2.2 Engineering Synthesis and Design

Comment

Engineering synthesis and design is the process of devising a system, component or process to meet specified needs. It is an iterative decision-making process in which engineering knowledge and skills are applied to optimally convert resources to meet stated objectives.

Each educational programme must include a significant design component. Students should develop an understanding of classical design methodology, which includes the formulation of design problem statements (objectives) and specifications, consideration of alternative solutions, synthesis and evaluation, prototyping/simulation/modelling, construction, testing and evaluation.

The scope of the design experience offered by a programme should match the requirements of practice in that discipline. Design should be integrated throughout the programme and should include team efforts.

The provider is required to demonstrate that the curriculum requires students to:

- Apply a range of analytical and problem solving tools and techniques to analyse broadly defined engineering problems
- Apply classical design methodology to develop solutions to broadly defined engineering problems,
- Consider realistic constraints and compliance factors
- Undertake engineering design and related project work, particularly through meaningful design experience in the final year that builds on the programme's technical foundations and provides an integrated opportunity to demonstrate a range of targeted graduate outcomes.

The provider is also required to demonstrate that it takes steps to:

2.2.1 maximise the use that is made of industry based design exercises, particularly in the final year.

2.3. Professional Practice

Comment Students should develop key contextual skills and be exposed to current professional practices in preparation for engineering practice. This may be integrated throughout the degree and may include a specific work experience requirement.

The provider is required to demonstrate that the curriculum:

2.3.1 includes development of key contextual skills and knowledge that underpin professional practice, including:

- appropriate communication skills for engineering activities,
- the principles and tools underpinning management of engineering projects
- the capability to make ethical decisions and regulate one's own professional conduct
- the knowledge to implement appropriate health and safety practices

2.3.2 Provides students with direct exposure to current engineering practices through some or all of the following:

- use of staff with industry experience
- practical experience in an engineering environment outside the teaching establishment;
- use of guest lecturers;
- industry visits and inspections;
- industry-based projects;
- assignments based on industry practices.
- Development of appropriate workplace skills and safety practices.

2.4. Sustainability

Comment *Material on sustainability should be integrated throughout the curriculum, so students can consider the impacts of design upon society, nations and the environment. A systems approach is encouraged, including interdisciplinary teams, to teach sustainable engineering concepts.*

The provider is required to demonstrate that the curriculum includes:

2.4.1 appropriate coverage of sustainable technologies and sustainable development methodologies

2.4.2 integrated consideration of the social and environmental effects of their engineering activities

3. Admission

> ***Comment***
> *IPENZ has a firm commitment to the ideal of a balanced education during the formative years at secondary school, and does not favour specialisation at an early age. Adequate standards of attainment at secondary school in the disciplines of mathematics and basic sciences, and communication skills in the English language are key components of a typical preparatory education, but tertiary providers are also encouraged to provide pathways into engineering study for students from alternative backgrounds who can demonstrate a desire and ability to cope with the programme . .*

The provider is required to demonstrate that:

3.1 Different entry points to the degree programme are permitted for applicants with appropriate prior learning and/or experience.

3.2 Students entering engineering technology degree programmes have the educational background to succeed at tertiary level in mathematics, engineering sciences, engineering subjects and supporting studies included in engineering technology degree programmes in New Zealand.

3.3 Students entering engineering technology degree programmes are competent in the English language and therefore should, on admission, provide evidence of proficiency in both written and oral English language skills. If students are admitted with English language deficiencies then special language support programmes must be provided for them.

3.4 There are appropriate support programmes for students admitted from disadvantaged or unconventional backgrounds.

3.5 There is a reasonable relationship between admission standards, student retention and graduation rates.

4 Assessment

> **Comment:**
> *Valid assessment processes are central to demonstrating consistent student attainment of the targeted graduate outcomes expected to be developed by a programme.*

The provider is required to demonstrate that:

4.1. there are specific and appropriate assessment processes that measure graduate capability and performance relative to the targeted graduate outcomes for the programme as a whole,

4.2. assessment practices within each course validly assess the contribution made to the development of targeted graduate outcomes for the programme as a whole

4.3. there are clear processes for:
- ensuring the validity of assessment
- ensuring that assessment is consistent
- benchmarking assessment standards with other institutions

Part 2: Institutional Infrastructure, Staffing and Culture

Comment
The quality of the environment within which a programme is taught is regarded as paramount in providing the educational experience necessary to engender independence of thought in its graduates and achieve the targeted graduate outcomes for the programme. In evaluating the environment, central importance will be placed upon the faculty, the support staff, the administration, the laboratories, the library, and the computing and other supporting facilities.

5 Academic Staff

Comment
The character of the educational experience is influenced strongly by the professional competence and outlook of the staff. In gauging the capabilities of the academic staff, IPENZ will look for evidence in such areas as qualifications and experience (in engineering and education); scholarship; awareness of recent advances in engineering knowledge and current practice in industry and engineering education; involvement in professional bodies, professional standing within IPENZ or other professional engineering bodies; and effective participation in professional development opportunities and programmes. Staff research and/or professional activities should include interaction with industry.

The provider is required to demonstrate that:

5.1. the academic staff devoted to the programme is sufficient to cover, in terms of experience and interest, all relevant subjects
5.2. a high proportion of staff possess appropriate academic, professional and experiential backgrounds in engineering
5.3. there are sufficient full-time staff to provide the necessary levels of student interaction and counselling, and staff participation in developing, controlling and administering the programme
5.4. no programme is critically dependent on one or two people
5.5. the programme leaders, relevant managers and academic staff, particularly those teaching at the advanced levels (year 2 and 3), collectively demonstrate active commitment to supporting collegial self-regulation in the New Zealand engineering profession. Evidence of this will include individual staff exhibiting several of the following characteristics:

- commitment to the concept of collegial self-regulation through active membership of and participation in the most relevant professional body (note: membership of international learned societies that do not maintain active local programmes would not, of itself, be counted in this context)
- presenting to local learned society conferences on how the staff member's research could be reflected into changed codes of practice relevant to the New Zealand practising engineering community;

- developing and presenting technical refresher courses to New Zealand engineers on how new (international or national) engineering knowledge should be reflected into New Zealand engineering practice;
- participating in working parties developing codes of practice or standards to be applied in the New Zealand engineering community;
- undertaking contract work in collaboration with industry;
- undertaking expert witness work;
- participating as practice area assessors in New Zealand competence assessment processes;
- participating as panel members on New Zealand degree accreditation activities
- involved on the committee of a branch, technical society or learned society in developing and delivering a programme of technical interest to local practising engineers
- participating regularly in professional development activities to advance their engineering knowledge and the application of this knowledge within industry
- actively engaged in the advancing engineering education
- maintaining networks with other engineering educators, nationally and internationally, to further their knowledge and competence in the design and teaching of engineering degree programmes and courses.

5.6. programme leaders are demonstrably competent engineers in good professional standing amongst the profession as whole. Good evidence of this would include formal recognition within the engineering profession through attainment of a competence-graded quality mark such as TIPENZ, MIPENZ, ETPract, CPEng or equivalent.

5.7. key academic staff teaching key project courses are currently competent engineers in the New Zealand context as judged by peers in the wider engineering profession. Good evidence of this would include formal recognition within the engineering profession through recent success in a competence assessment e.g. for ETPract/TIPENZ or CPEng/MIPENZ.

5.8. Academic staffing and teaching loads allow adequate interaction with students, support the range of learning experiences offered and allow adequate opportunity for professional engagement outside of teaching.

NB: In evaluating this criterion benchmarking with other national and international institutions will be considered and provision of such evidence is encouraged.

6 Technical staff

Comment
Laboratory and project work are essential components in an engineering technology degree programme.

The provider is required to demonstrate that:

6.1 there are sufficient, competent technical staff to ensure laboratory experiments reflect current technologies and student project work can include the design, construction and testing of products, processes, or systems.

7 Laboratories

Comment
Practical laboratory based work is an essential component of an engineering technology degree.

The provider is required to demonstrate that:

7.1 there is sufficient, appropriately equipped laboratory space, reflecting current technologies, to support students' practical and project-based study

7.2 health and safety policies and practices in laboratory spaces satisfy legal requirements and are in line with good practice in industry.

8 Independent Study Facilities

Comment
Independent investigation and enquiry is an important component of degree level study and important skills for an engineering technologist.

The provider is required to demonstrate that:

8.1 students have appropriate independent access to laboratories to support project/research based study

8.2 students have adequate access to sufficient library and computer resources to support their learning.

9 Educational and Professional Culture

Comment
IPENZ will look for evidence of a dynamic, innovative and outward-looking intellectual climate in the engineering school. Staff development programmes should aim at developing teaching practice as well as discipline expertise. The curriculum and pervading culture should reflect the school's status as a professional school; it must be gender-inclusive, and take cognisance of The Treaty of Waitangi.

The provider is required to demonstrate that:

9.1 the culture underpinning professional self-regulation is developed amongst students, through active support for:

- relevant professional bodies and learned societies to engage with students
- operating student societies/groups that run beneficial collegial activities amongst the student cohort

9.2 there are clearly documented processes that provide for significant involvement by all teaching staff in ongoing curriculum development, improving the effectiveness of learning and teaching and promoting and supporting self-directed learning

9.3 staff are aware of current educational thinking and best practice and are supported in developing their teaching practices.

Part 3: Management structures and quality systems to sustain and enhance the programme and its delivery

10 Identifiable Management structure

Comment
IPENZ considers that it is essential that there is an identifiable management structure responsible for engineering education within the tertiary education provider awarding the degree. Most commonly this will take the form of an engineering school (faculty, department) – a substantial organisational entity whose prime focus and responsibility is engineering education and scholarship. Other forms of organisation may be acceptable but it is unlikely, for example, that an engineering programme would be accredited if it were taught and managed by a handful of staff, otherwise undifferentiated within (say) a Faculty of Science or a Faculty of Information Technology. It will normally be expected that the engineering school would have responsibility – subject to TEO internal approval processes – for the design, principal content and delivery of engineering programmes, for managing associated resources, and for the appointment and professional activity of staff. If this is not the case, the tertiary education provider will need to demonstrate how sufficient engineering expertise is brought to bear on decisions in these areas.

The provider is required to demonstrate that:

10.1 there is an identifiable management structure that ensures that engineering expertise is central to decision making relating to the design, principal content and delivery of engineering programmes, for managing associated resources, and for the appointment and professional activity of staff.

11 Institutional Support and Leadership

Comment
Strong institutional support for a provider's engineering programmes is a key component for their long term sustainability and success.

The provider is required to demonstrate that:

11.1 engineering education is seen as a significant long-term component of its activity

11.2 it has adequate arrangements for planning, developing, delivering and reviewing of engineering programmes, and for supporting the associated professional activities of staff

11.3 it has adequate policies and mechanisms for funding its engineering programmes and facilitating the generation of funds from external sources; for attracting, appointing, retaining and rewarding well qualified staff and providing for their ongoing professional development; and for providing and updating infrastructure and support services

11.4 creative leadership is available to the engineering school by appointing highly-qualified and experienced senior staff in sufficient numbers to ensure that the art of engineering and the use of engineering judgement can be inculcated in students.

12. Advice from Industry

Comment
Valid preparation of students for professional engineering practice requires continuing interaction with industry. There should be clear processes in place to ensure the programme remains relevant to industry and it is expected that an advisory group, including senior industrial representatives, is involved at policy level and in formulating and managing overall evaluation processes rather than at the level of detailed curriculum design.

The provider is required to demonstrate that:

12.1 there is a formally-constituted advisory mechanism/s involving the active participation of practising professional engineers and leading employers of engineering graduates in:

- defining programme objectives and their periodic evaluation and updating
- developing and operating processes for evaluating the capabilities of graduating students
- the subsequent monitoring of graduate performance in employment.
- reviewing the ongoing relevance to industry of targeted graduate outcomes

12.2 programme approval and review processes take cognisance of advice from industry on future needs.

13 Quality Systems and Processes

Comment
Engineering providers are expected to have exemplary quality assurance systems, and to regularly monitor and systematically improve their engineering programmes to ensure their graduates are adequately prepared to enter the engineering profession.
There should be systems in place to ensure that the stated programme outcomes are consistently met and that programme objectives and programme quality are continuously reviewed and improved.

The provider is required to demonstrate that:

13.1 there are documented processes for developing new programmes that cover programme planning, curriculum development and programme approval

13.2 there are documented processes for the ongoing review of programmes and their delivery

13.3 there are processes for securing feedback and comment from students, graduates, employers of engineers, and representatives of the community; and evidence of their systematic application to the review and continuing improvement of programme objectives, curriculum and content, and the quality of learning and teaching. Post-programme processes should include graduate employment data, alumni surveys documenting achievement, and employer surveys of longer-term performance and development

13.4 there are documented audit processes that ensure the consistent application of documented policies and procedures

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