BOARD NOTICE

BOARD NOTICE 7 OF 2013

ECSA

Engineering Council of South Africa

Invitation to Comment on the Proposed ECSA Technology Qualification Standards

1. Background

The HEQF compliant qualifications attached were developed to replace the NATED qualifications and to comply with the Policy on Higher Education Qualifications: Oct 2007. The following information is found in the policy:

- It replaces NATED 116, 150 & 151
- Makes the HEQF an integral part of the NQF
- It is based on a 10-level NQF
- Sets common parameters and criteria for the design of higher education qualifications.

The attached qualifications are:

NO.	TITLE	LEVEL	CREDIT(S)	EDUCATIONAL REQUIREMENT
1	Diploma in Engineering Technology	06	280	Professional Technician
2	Bachelor of Engineering Technology Honours	08	140	Entrance to a Master's Degree

2. QUALIFICATIONS GENERATION PROCESS

The Engineering Standards Generating Body (ESGB) undertook the work of developing the Diploma in Engineering Technology and the Bachelor of Engineering Technology Honours in **Standards Generating Groups**. These Standards Generating Groups comprised of an ESGB member as chairperson and forty other technical experts, which represented stakeholders (including providers, industry, professional institutes, SETAs and state departments).

3. PURPOSE FOR THE PROCESS

The Technology Programme Accreditation Committee (TPAC) of ECSA, has recognised the need for developing standards for technology qualifications aligned to the Revised HEQF. This has come about for the following reasons.

- The qualifications reflected in NATED Reports 116, 150 and 151 are to be phased out.
- The Standards for the HEQF technology qualifications required the development of Exit Level Outcomes.
- ECSA is a signatory to the Dublin Accord (Technicians) and the Sydney Accord (Technologist) which will in future use their Graduate Attributes as its base for judging the substantial equivalency of programmes accredited by signatories. ECSA has, along with other signatories, undergone a Gap Analysis in which gaps between the signatory's qualification standard and the Graduate Attributes are identified and a plan for closing the Gaps over time is formulated. While the alignment of the ECSA Standard and the Graduate Attributes is largely complete, the TPAC proposes to complete the alignment through a number of changes.

The proposed standards resulting from this process is now published for comment. A revision will be made as a result of the comments and the document put to the ECSA Council for approval. A phasing-in period will be announced thereafter.
The BEng Tech Hons and Diploma in Engineering Technology standards rely on the ECSA policy document E-01-P: Background the Accreditation of Engineering Programmes for definitions and the definition of the formula for calculating credits.

4. SUBMISSION OF COMMENTS

Interested parties are requested to submit comments not later than **Wednesday, 13 February 2013** by e-mail to the ECSA Education Manager, Samantha Naidoo at Samantha@ecsa.co.za.

ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			ECSA
Qualification Standard for Diploma in Engineering Technology: NQF Level 6			
Status:			
Document: E-08-PN	**Rev 1**		

Background: The ECSA Education System Documents

The documents that define the Engineering Council of South Africa (ECSA) system for accreditation of programmes meeting educational requirements for professional categories are shown in Figure 1 which also locates the current document.

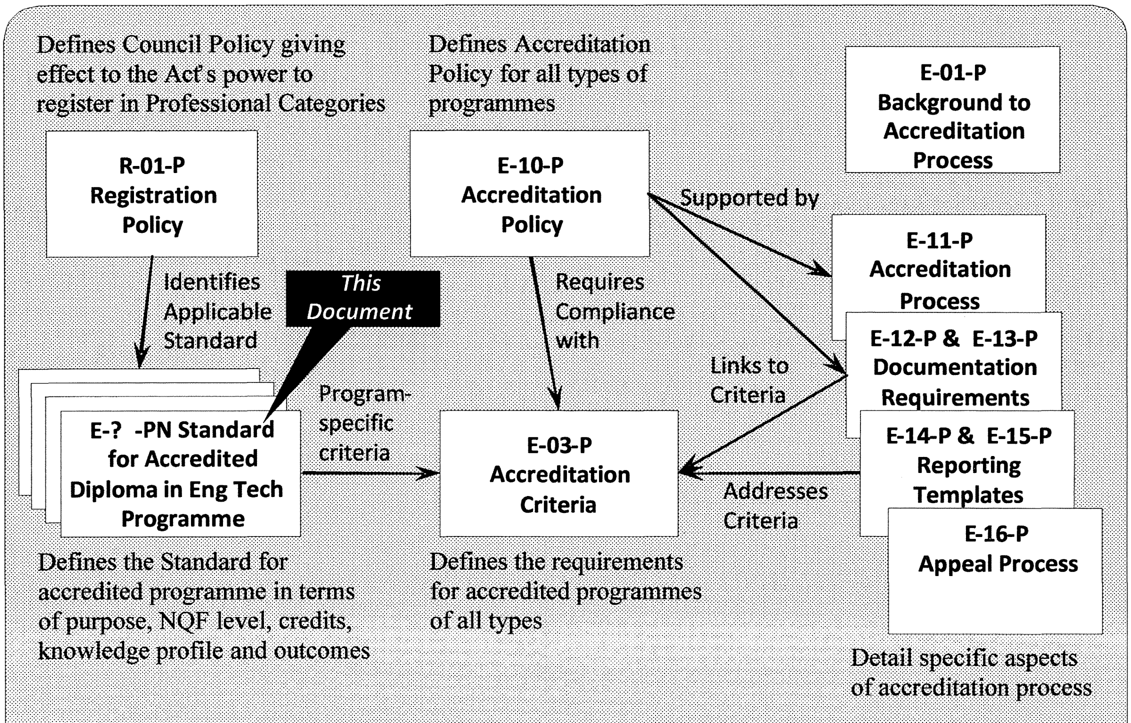

Figure 1: Documents defining the ECSA Accreditation System

1. Purpose

This document defines the standard for accredited Diploma in Engineering Technology-type programmes in terms of programme design criteria, a knowledge profile and a set of exit level outcomes. This standard is referred to in the Accreditation Criteria defined in ECSA document E-03-P.

2. HEQF and NQF Specification

Field: Manufacturing, Engineering and Technology
Sub-Field: Engineering and Related Design
NQF Level: Level 6
Credits: 280 credits total: Not less than 120 Credits shall be at NQF level 6

Acceptable titles: Diploma in Engineering Technology
Abbreviation: Dip (Eng Tech)
Qualifiers: See section 3

3. Qualifiers

The qualification must have a qualifier(s) defined in the provider's rules for the Diploma that is reflected on the academic transcript and Diploma certificate, subject to the following:

1. There must be at least one qualifier which contains the word Engineering Technology together with a disciplinary description such as: Agricultural, Aeronautical, Chemical, Civil, Computer, Electrical, Electro-mechanical, Electronic, Environmental, Industrial, Extractive Metallurgical, Information, Materials, Mechanical, Mechatronics, Metallurgical, Mineral(s) Processing, Physical Metallurgical and Mining. Qualifiers are not restricted to this list.
2. A second qualifier, if present, must indicate a focus area within the field of the first qualifier such as: Environmental, Information, Extractive Metallurgical, Minerals Processing and Physical Metallurgical.
3. The qualifier(s) must:
   - clearly indicate the nature and purpose of the programme;
   - be consistent with the fundamental engineering science content of the programme; and
   - be comparable with typical programmes within the Dublin Accord Signatories.
4. The target market indicated by the qualifier(s) may be a traditional discipline of engineering or a branch of engineering or a substantial industrial sector. Formal education for niche markets should be satisfied by broad undergraduate programmes such as specified in this standard followed by specialized course-based programmes.

In the case of a provider offering programmes with different titles but having only minor differences in content or undifferentiated purposes, only one programme should be accredited.

Examples of acceptable qualification titles in accordance with HEQF policy are:

- Diploma in Engineering Technology in Civil Engineering, abbreviated Dip (Eng Tech) (Civil Engineering)

In case of a second *Qualifier*:

- Diploma in Engineering Technology in Civil Engineering in Environmental Engineering, abbreviated, Dip (Eng Tech) (Civil Engineering) (Environmental)

4. Purpose of the Qualification

This qualification is primarily vocational, or industry oriented. The knowledge emphasises general principles and application or technology transfer. The qualification provides students with a sound knowledge base in a particular field or discipline and the ability to apply their knowledge and skills to particular career or professional contexts, while equipping them to undertake more specialised and intensive learning. Programmes leading to this qualification tend to have a strong vocational, professional or career focus and holders of this qualification are normally prepared to enter a specific niche in the labour market.

Specifically the purpose of educational programmes designed to meet this qualification are to build the necessary knowledge, understanding, abilities and skills required for further learning towards becoming a competent practicing Professional Engineering Technician. This qualification provides:

1. Preparation for careers in engineering and areas that potentially benefit from engineering skills, for achieving technical proficiency and to make a contribution to the economy and national development;

2. The educational base required for registration as a Candidate and/or a Professional Engineering Technician with ECSA. (Refer to qualification rules).
3. Entry to programmes e.g. Diploma or Bachelor Degree programmes.
4. Entry to an Advanced Diploma upon successful completion of a work-integrated learning component, or a combination of work-integrated learning and coursework, equivalent to 120 credits.

Engineering students completing this qualification will demonstrate competence in all the Exit Level Outcomes contained in this standard.

5. Rationale

Professional Engineering Technicians are characterized by the ability to apply proven, commonly understood techniques procedures, practices and codes to solve *well-defined* engineering problems. They manage and supervise engineering operations, construction and activities. They work independently and responsibly within an allocated area or under guidance.

Professional Engineering Technicians must therefore have a working understanding of engineering sciences underlying the techniques used, together with financial, commercial, legal, socio-economic, health, safety and environmental methodologies, procedures and best practices.

The process of professional development of a Professional Engineering Technician starts with the attainment of a qualification that meets this standard. After graduation a programme of training and experience is completed to attain the competencies for registration in the category Professional Engineering Technician.

6. Programme Structure

The programme leading to the qualification shall contain a minimum of 280 credits, with not less than 120 credits at NQF level 6. Credits shall be distributed in order to create a coherent progression of learning toward the exit level.

6.1 Knowledge Profile of the Graduate

The content of the educational programme when analysed by knowledge area shall not fall below the minimum credits in each knowledge area as listed below.

Table 1: Minimum credits in knowledge areas	
Total	280
Mathematical Sciences	28
Natural Sciences	21
Engineering Sciences	126
Engineering Design & Synthesis	28
Computing and IT	21
Complementary Studies	14
Available for re-allocation in above areas	42

Credits available for reallocation must be assigned to the knowledge areas to form a coherent, balanced programme.

The method of calculation of credits and allocation to knowledge area is defined in ECSA document E-01-P or Appendix A.

6.2 Core and Specialist Requirements

The programme shall have a coherent core of mathematics, basic sciences and fundamental engineering sciences totalling not less than 50% of the total credits that provides a viable platform for further studies and lifelong learning. The coherent core must enable development in a traditional discipline or in an emerging field. The coherent core includes fundamental elements. The provider may allow elective credits, subject to the minimum credits in each knowledge area and the exit level outcomes being satisfied for all choices.

A programme shall contain specialist engineering study at the exit level. Specialist study may lead to elective or compulsory credits. Specialist study may take on many forms including further deepening of a theme in the core, a new sub-discipline, or a specialist topic building on the core. It is recognized that the extent of specialist study is of necessity limited in view of the need to provide a substantial coherent core. Specialist study may take the form of compulsory or elective credits.

In the Complementary Studies area, it covers those disciplines outside of engineering sciences, basic sciences and mathematics which are relevant to the practice of engineering in two ways: (a) principles, results and method are applied in the practice of engineering, including engineering economics, the impact of technology on society and effective communication; and (b) study broadens the student's perspective in the humanities or social sciences to support an understanding of the world. Underpinning Complementary Studies knowledge of type (b) must be sufficient and appropriate to support the student in satisfying Exit Level Outcomes 6, 7 and 10 in the graduates specialized practice area.

6.3 Curriculum Content

This qualification standard does not specify detailed curriculum content. The fundamental and specialist engineering science content must be consistent with the designation of the qualification.

Designers of specific qualifications may build on this generic base by specifying occupation-related content and specific skills required. The particular occupation may also require other qualifications, learnerships, skills programmes or further learning.

7. Access to Qualification

This standard is specified as a set of exit level outcomes and overall distribution of credits. Providers therefore have the freedom to construct programmes geared to different levels of preparedness of learners, including:

- Use of access programmes for learners who do not meet the minimum requirements;
- Creating articulation paths from other qualifications.

8. Minimum Learning Assumed to be in Place

The minimum entry requirement is the National Senior Certificate or the National Certificate (Vocational) with appropriate subject combinations and levels of achievement, as defined in the Government Gazette, Vol 751, No 32131 of 11 July 2008, and in the *Government Gazette,* Vol. 533, No. 32743, November 2009. Alternatively, a Higher Certificate or an Advanced Certificate or Diploma in a cognate field may satisfy the minimum admission requirements.

Note: Appropriate Language, Mathematics and Physical Science are required at NQF level 4.

9. Exit Level Outcomes

Exit Level Outcomes defined below are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulated practice environment. Words and phrases having specific meaning are defined in this document or in the ECSA document E-01-P.

Notes:

1. For Critical Cross-field Outcomes linked to Exit Level Outcomes refer to normative information in Appendix B.
2. For exemplified informative associated assessment criteria, refer to Appendix C.
3. The Level Descriptor: *Well-Defined engineering problems* applicable to this Qualification Standard is characterised by:
   a. Can be solved mainly by practical engineering knowledge, underpinned by related theory;
   and one or more of the characteristics:
   b. are largely defined but may require clarification;
   c. are discrete, focussed tasks within engineering systems;
   d. are routine, frequently encountered, may be unfamiliar but in familiar context;
   and one or more of the characteristics:
   e. can be solved in standardized or prescribed ways;
   f. are encompassed by standards, codes and documented procedures; requires authorization to work outside limits;
   g. information is concrete and largely complete, but requires checking and possible supplementation;
   h. involve several issues but few of these imposing conflicting constraints and a limited range of interested and affected parties.

General Range Statement: The competencies defined in the ten exit level outcomes may be demonstrated in a provider-based and / or simulated workplace context.

Exit Level Outcome 1: Problem Solving

Apply engineering principles to systematically diagnose and solve *well-defined* engineering problems.

Exit Level Outcome 2: Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural science and engineering sciences to applied engineering procedures, processes, systems and methodologies to solve *well-defined* engineering problems.

Range Statement: Knowledge of mathematics, natural science and engineering science is characterized by:

1. A coherent range of fundamental principles in mathematics and natural science underlying a sub-discipline or recognised practice area.
2. A coherent range of fundamental principles in engineering science and technology underlying an engineering sub-discipline or recognised practice area.
3. A codified practical knowledge in recognised practice area.
4. The use of mathematics, natural sciences and engineering sciences, supported by established mathematical formulas, codified engineering analysis, methods and procedures to solve well-defined engineering problems.

Exit Level Outcome 3: Engineering Design

Perform procedural design of components, systems, works, products or processes to meet desired needs normally within applicable standards, codes of practice and legislation.

Range Statement: Design problems used in assessment must conform to the definition of *well-defined* engineering problems:

1. A design project should be used to provide evidence of compliance with this outcome.
2. The problem would be typical of that which the graduate would participate in a typical employment situation shortly after graduation.
3. The selection of components, systems, engineering works, products or processes to be designed is dependent on the sub-discipline.

4. A design project should include one or more of the following impacts: social, economic, legal, health, safety, and environmental.

Exit Level Outcome 4: Investigation

Conduct investigations of *well-defined* problems through locating and searching relevant codes and catalogues, conducting standard tests, experiments and measurements.

Range Statement: The balance of investigation should be appropriate to the discipline. An investigation should be typical of those in which the graduate would participate in an employment situation shortly after graduation.

Note: An investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon.

Exit Level Outcome 5: Engineering methods, skills, tools, including Information technology

Use appropriate techniques, resources, and modern engineering tools including information technology for the solution of *well-defined* engineering problems, with an awareness of the limitations, restrictions, premises, assumptions and constraints.

Range Statement: A range of methods, skills and tools appropriate to the discipline of the program including:

1. Sub-discipline-specific tools processes or procedures.
2. Computer packages for computation, simulation, and information handling;
3. Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork;
4. Basic techniques from economics, management, and health, safety and environmental protection.

Exit Level Outcome 6: Professional and Technical Communication

Communicate effectively, both orally and in writing within an engineering context.

Range Statement: Material to be communicated is in a simulated professional context:

1. Audiences are engineering peers, academic personnel and related engineering persons using appropriate formats.
2. Written reports range from short (minimum 300 words) to long (a minimum of 2 000 words excluding tables, diagrams and appendices), covering material at the exit level.
1. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, physical models, bills of quantities as well as subject-specific methods.

Exit Level Outcome 7: Impact of Engineering Activity

Demonstrate knowledge and understanding of the impact of engineering activity on the society, economy, industrial and physical environment, and address issues by defined procedures.

Range Statement: The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the sub-discipline of the qualification. Evidence may include case studies typical of the technical practice situations in which the graduate is likely to participate.

Issues and impacts to be addressed:

1. Are encompassed by standards and documented codes of practice.
2. Involve a limited range of stakeholders with differing needs.
3. Have consequences that are locally important and are not far reaching.
4. Are *well-defined* and discrete and part of an engineering system.

Exit Level Outcome 8: Individual and Teamwork

Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a technical team and to manage projects.

Range Statement:

1. The ability to manage a project should be demonstrated in the form of the project indicated in ELO 3.
2. Tasks are discipline specific and within the technical competence of the graduate.
3. Projects could include: laboratories, business plans, design etc
4. Management principles include:
5. Planning: set objectives, select strategies, implement strategies and review achievement.
6. Organising: set operational model, identify and assign tasks, identify inputs, delegate responsibility and authority.
7. Leading: give directions, set example, communicate, motivate.
8. Controlling: monitor performance, check against standards, identify variations and take remedial action.

Exit Level Outcome 9: Independent Learning

Engage in independent and life-long learning through well-developed learning skills.

Range Statement: The learning context is well-structured with some unfamiliar elements.

Exit Level Outcome 10: Engineering Professionalism

Understand and commit to professional ethics, responsibilities and norms of engineering technical practice.

Range Statement: Evidence includes case studies, memorandum of agreement, code of conduct, membership of professional societies etc typical of engineering practice situations in which the graduate is likely to participate.

10. International Comparability

International comparability of engineering education qualifications is ensured through the Washington, Sydney and Dublin Accords, all being members of the International Engineering Alliance (IEA). International comparability of this engineering technician education qualification is ensured through the Dublin Accord.

The exit level outcomes and level descriptors defined in this qualification are aligned with the attributes of a Dublin Accord technician graduate in the International Engineering Alliance's Graduate Attributes and professional Competencies (See www.ieagreements.org).

11. Integrated Assessment

Providers of programmes shall in the quality assurance process demonstrate that an effective integrated assessment strategy is used. Clearly identified components of assessment must address summative assessment of the exit level outcomes. Evidence should be derived from major work or multiple instances of limited scale work.

12. Recognition of Prior Learning

Recognition of prior learning (RPL) may be used to demonstrate competence for admission to this programme. This qualification may be achieved in part through recognition of prior learning processes.

Credits achieved through RPL must not exceed 50% of the total credits and must not include credits at the exit level.

13. Articulation Possibilities

Candidates who complete the 280-credit Diploma may enter an Advanced Diploma upon successful completion of a work integrated learning component or a combination of work-integrated learning and coursework equivalent to 120 credits that is approved and accredited by an education provider and/or a professional body and a Quality Council. A qualification may not be awarded for early exit from a Diploma programme.

Completion of a 280-credit Diploma meets the minimum entry requirement for admission to a Diploma or Bachelor's degree. Accumulated credits may also be presented for admission into a cognate 360-credit Diploma in Engineering or a Bachelor's Degree programme.

14. Moderation and Registration of Assessors

Providers of programmes shall in the quality assurance process demonstrate that an effective moderation process exists to ensure that the assessment system is consistent and fair.

Registration of assessors is delegated by the Higher Education Quality Committee to the Higher Education providers responsible for programmes.

Appendix A: Method of Calculation of Credits and Allocation to Knowledge Area.

The method of calculation assumes that certain activities are scheduled on a regular weekly basis while others can only be quantified as a total activity over the duration of a course or module. This calculation makes the following assumptions:

1. Classroom or other scheduled contact activity generates notional hours of the student's own time for each hour of scheduled contact. The total is given by a multiplier applied to the contact time.
2. Two weeks of full-time activity accounts for assessment in a semester.
3. Assigned work generates only the notional hours judged to be necessary for completion of the work and is not multiplied.

Define for each course or module identified in the rules for the degree: Type of Activity, Time Unit in Hours and Contact Time Multiplier

The credit for the course is: C = {W (L*TL *ML + T*TT *MT) + P*TP *MP + X*TX *MX + A*TA }/10

Where:

L	= number of lectures per week,
TL	= duration of a lecture period
ML	= total work per lecture period
T	= number of tutorial per week
TT	= duration of a tutorial period
MT	= total work per tutorial period
P	= total practical periods
T	= duration of a practical period
MP	= total work per practical period
X	= total other contact periods
TX	= duration of other period
MX	= total work per other period
A	= total assignment non-contact Hours
TA	= 1 hour
W	= number of weeks the course lasts (actual + 2 week per semester for examinations, if applicable to the course or module)

The resulting credit for a course or value may be divided between more than one knowledge area. In allocating the credit for a course to multiple knowledge areas, only new knowledge or skills in a particular area may be counted. Knowledge and skills developed in other courses and used in the course in question shall not be counted. Such knowledge is classified by the nature of the area in which it is applied. In summary, no knowledge is counted more than once as being new.

Appendix B: Consistency of Exit Level Outcomes with Critical Cross-field Outcomes (Normative)

SAQA Critical Cross-Field Outcomes	Equivalent Exit Level Outcome
Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.	ELO 1.2.3.5
Working effectively with others as a member of a team, group, organisation and community.	ELO 8
Organising and managing oneself and one's activities responsibly and effectively	ELO 8
Collecting, analysing, organising and critically evaluating information.	ELO 1, 3, 5
Communicating effectively using visual, mathematical and/or language skills	ELO 2, 6
Using science and technology effectively and critically, showing responsibility toward the environment and health of others	ELO 2, 3, 4, 5, 7
Demonstrating an understanding of the world as a set of related systems by recognising that problem context do not exist in isolation	ELO 1, 3
Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of: • reflecting on and exploring a variety of strategies to learn more effectively • participating as responsible citizens in the life of local, national and global communities • being culturally and aesthetically sensitive across a range of contexts • exploring education and career opportunities • developing entrepreneurial opportunities	 ELO 9 ELO 10 ELO 7 ELO 8 ELO 3

Appendix C: Exemplified Associated Assessment Criteria

The assessment criteria presented here are typifying, not normative.

Exit Level Outcome 1:

1.1 The problem is analysed and defined and criteria are identified for an acceptable solution.
1.2 Relevant information and engineering knowledge and skills are identified and used for solving the problem.
1.3 Various approaches are considered and formulated that would lead to workable solutions.
1.4 Solutions are modelled and analysed.
1.5 Solutions are evaluated and the best solution is selected.
1.6 The solution is formulated and presented in an appropriate form.

Exit Level Outcome 2:

2.1 An appropriate mix of knowledge of mathematics, statistics, natural science and engineering science knowledge at a fundamental level is brought to bear on the solution of *well-defined* engineering problems.
2.2 Applicable principles and laws are used.
2.3 Engineering materials, components, systems or processes are analysed.
2.4 Concepts and ideas are presented in a logical and methodical manner.
2.5 Reasoning about engineering materials, components, systems or processes is performed.
2.6 Procedures for dealing with uncertain/ undefined/ill defined variables are outlined and justified.
2.7 Work is performed within the boundaries of the practice area

Exit Level Outcome 3:

3.1 The design problem is formulated to satisfy user needs, applicable standards, codes of practice and legislation.
3.2 The design process is planned and managed to focus on important issues and recognises and deals with constraints.
3.3 Knowledge, information and resources are acquired and evaluated in order to apply appropriate principles and design tools to provide a workable solution.
3.4 Design tasks are performed that include analysis and optimisation of the product, or system or process, subject to relevant premises, assumptions and constraints.
3.5 Alternatives are evaluated for implementation and a preferred solution is selected based on techno-economic analysis and judgement.
3.6 The design logic and relevant information is communicated in a technical report.
3.7 Procedures are applied to evaluate the selected design and assessed in terms of the impact and benefits.

Exit Level Outcome 4:

4.1 The scope of the investigation is defined.
4.2 Investigations are planned and conducted within an appropriate discipline.
4.3 Available literature is searched and material is evaluated for suitability to the investigation.
4.4 Relevant equipment or software is selected and appropriately used for the investigation.
4.5 Data obtained is analysed and interpreted.
4.6 Conclusions are drawn from an analysis of all available evidence.
4.7 The purpose, process and outcomes of the investigation are recorded in a technical report.

Exit Level Outcome 5:
5.1 The method, skill or tool is assessed for applicability and limitations against the required result.
5.2 The method, skill or tool is applied correctly.
5.3 Results produced by the method, skill or tool are tested and assessed
5.4 Relevant computer applications are selected and used.

Exit Level Outcome 6:
6.1 The structure, style and language of written and oral communication is appropriate for the purpose of the communication and the target audience.
6.2 Graphics used are appropriate and effective in enhancing the meaning of the text.
6.3 Visual materials used enhance oral communications.
6.4 Information is provided in a format that can be used by others involved in the engineering activity.
6.5 Oral communication is delivered with the intended meaning being apparent.

Exit Level Outcome 7:
7.1 The impact of technology is demonstrated in terms of the benefits and limitations to society.
7.2 The engineering activity is analysed in terms of the impact on occupational and public health and safety.
7.3 The engineering activity is analysed in terms of the impact on the physical environment.
7.4 The methods to minimise/mitigate impacts outlined in 7.2 and 7.3 are considered.

Exit Level Outcome 8:
8.1 The principles of planning, organising, leading and controlling are explained.
8.2 Individual work is carried out effectively, strategically and on time.
8.3 Individual contributions made to team activities support the output of the team as a whole.
8.4 Functioning as a team leader is demonstrated.
8.5 A project is organised and managed.
8.6 Effective communication carried out in the context of individual and team work.

Exit Level Outcome 9:
9.1 Learning tasks are identified, planned and managed.
9.2 The requirement for independent learning is identified/ recognised and demonstrated.
9.3 Relevant information is sourced, organised and evaluated
9.4 Knowledge acquired outside of formal instruction is comprehended and applied.
9.5 Awareness is displayed of the need to maintain continued competence through keeping abreast of up-to-date tools and techniques available in the workplace.

Exit Level Outcome 10:
10.1 The nature and complexity of ethical dilemmas is described in terms of required practices, legislation and limitations of authority.
10.2 The ethical implications of engineering decisions are described in terms of the impact on environment, the business, costs and trustworthiness.
10.3 Judgements in decision making during problem solving and design are ethical and within acceptable boundaries of current competence.
10.4 Responsibility is accepted for consequences stemming from own actions or inaction.
10.5 Decision making is limited to area of current competence.

Revision History

Version	Date	Revision Authorized by	Nature of revision
Rev1	10 May 2012	Technology SGG Working Group	Reconfiguration of document approved by Council to align with E-02-PE

ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*		
Qualification Standard for Bachelor of Engineering Technology Honours: NQF Level 8		
Status:		
Document : E-09-PT	**Rev 1**	

Background: The ECSA Education System Documents

The documents that define the Engineering Council of South Africa (ECSA) system for accreditation of programmes meeting educational requirements for professional categories are shown in Figure 1 which also locates the current document.

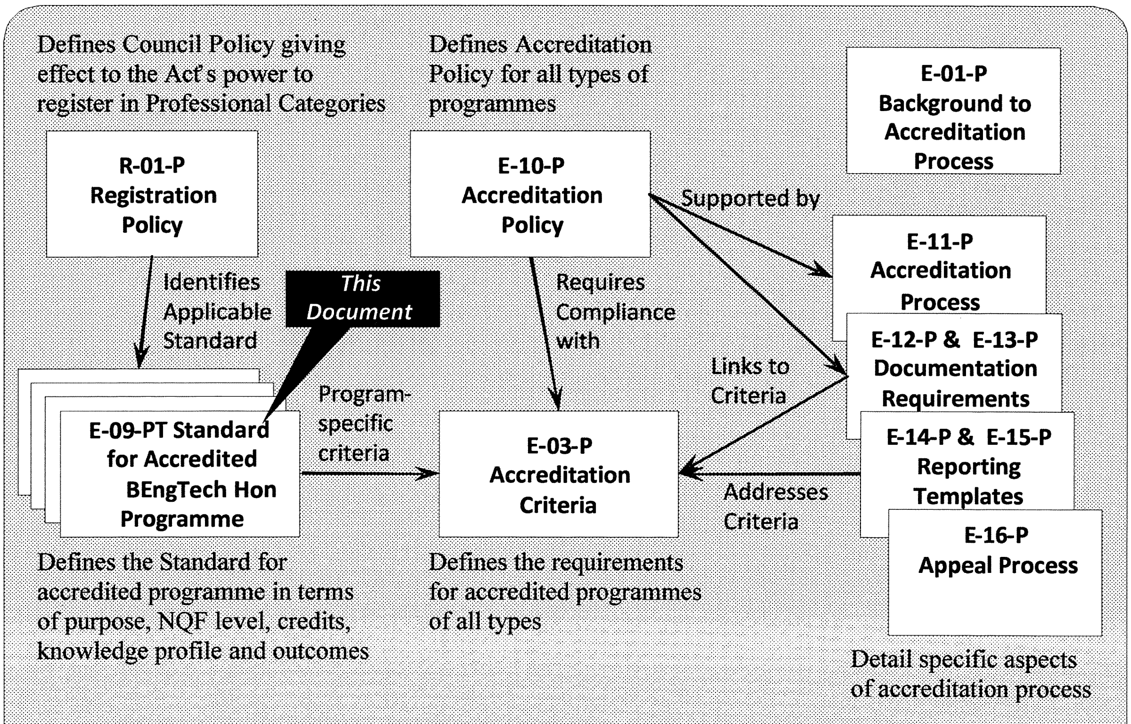

Figure 1: Documents defining the ECSA Accreditation System

1. Purpose

This document defines the standard for accredited Bachelor of Engineering Technology Honours-type programmes in terms of programme design criteria, a knowledge profile and a set of exit level outcomes. This standard is referred to in the Accreditation Criteria defined in ECSA document E-03-P.

2. HEQF and NQF Specification

Field: Manufacturing, Engineering and Technology
Sub-Field: Engineering and Related Design
NQF Level: Level 8
Credits: 140 credits total: Not less than 120 Credits shall be at NQF level 8

Acceptable titles: Bachelor of Engineering Technology Honours
Abbreviation: BEngTech Hons
Qualifiers: See section 3

3. Qualifiers

The *qualification type* is the first name given to a qualification.
The *designator* is the second name given to a qualification, to indicate its broad area of study, discipline or profession.
The third name given to a qualification type is the *qualifier.*

All Degrees (Bachelor, Master and Doctor) have designators, but designators are not used for certificates and diplomas. The linking word between the qualification type and the designator is *of (e.g.* Bachelor of Engineering Technology Honours), and when abbreviated the 'of' is omitted (e.g. BEngTech Hons).

The third name given to a qualification type is the *qualifier.* Qualifiers may be used in all qualification types in order to indicate a field of specialisation. The linking word between the qualification type or its designator and the qualifier is always *in* (e.g. Bachelor of Engineering Technology Honours *in* Electrical Engineering, Abbreviated form: BEngTech Hons (*Electrical*).

In order to use a qualifier, at least 50% of the minimum total credits for the qualification and at least 50% of the minimum credits at the qualification's exit level must be in the field of specialisation denoted by the qualifier. The same applies to the use of a second qualifier. Qualifiers and second qualifiers are attached to a qualification type and designators are subject to the criteria set by the CHE; e.g. Bachelor of Engineering Technology Honours *in* Electrical Engineering *in* Computer Systems. Abbreviated form: BEngTech Hons (*Electrical*) (*Computer Systems*).

1. The qualifier(s) must:
   - clearly indicate the nature and purpose of the programme; and
   - be consistent with the fundamental engineering science content on the programme.

2. The target market indicated by the qualifier(s) may be a traditional discipline of engineering or a branch of engineering or a substantial industry area. Formal education for niche markets should be satisfied by broad undergraduate programmes such as specified in this standard followed by specialized course-based programmes.

In the case of a provider offering programmes with different designations but having only minor differences in content or undifferentiated purposes, only one programme should be accredited.

Examples of acceptable designations in accordance with HEQF policy are:
- Bachelor of Engineering Technology Honours in Civil Engineering, abbreviated BEngTech Hons (*Civil*)
- Bachelor of Engineering Technology Honours in Civil Engineering in Environmental Engineering, abbreviated BEngTech Hons (*Civil*) (*Environmental*)

4. Purpose of the Qualification

The Bachelor of Engineering Technology Honours Degree is a postgraduate qualification, characterised by the fact that it prepares students for industry and research. This qualification typically follows a Bachelor's Degree, Advanced Diploma or relevant level 7 qualification and serves to consolidate and deepen the student's expertise in a particular discipline and to develop research capacity in the methodology and techniques of that discipline.

In some cases a Bachelor of Engineering Technology Honours Degree carries recognition by an appropriate professional or statutory body. This qualification demands a high level of theoretical engagement and intellectual independence. The Bachelor of Engineering Technology Honours Degree may form part of a combination of qualifications to meet the educational requirements for registration in the category candidate engineer.

This qualification provides:

1. Preparation for careers in engineering itself and areas that potentially benefit from engineering skills, for achieving technological proficiency and to make a contribution to the economy and national development;
2. Entry to NQF level 9 Masters programmes e.g. MSc/MEng

Engineering students completing this qualification will demonstrate competence in all the Exit Level Outcomes contained in this standard.

5. Rationale

The Bachelor of Engineering Technology Honours Degree enhances the application of research and development as well as specialist and contextual knowledge to meet the minimum entry requirement for admission to a cognate Masters Degree. The Master's Degree programme is usually in the area of specialisation of the Bachelor Honours Degree.

5.1 Characteristic Profile of the Graduate:

- Consolidates and deepens the graduates expertise in a specialised area of a particular discipline and develops research capacity in the methodology and techniques of that discipline
- Work independently and responsibly, applying original thought and judgment to technical and risk-based decisions in complex situations.
- Have a broad, fundamentals-based appreciation of engineering sciences, with depth in specific areas, together with knowledge of financial, commercial, legal, social and economic, health, safety and environmental matters.

6. Programme Structure

The programme leading to the qualification shall contain a minimum of 140 credits including a research project of no less than 30 credits. Not less than 120 Credits shall be at NQF level 8. Credits shall be distributed in order to create a coherent progression of learning toward the exit level.

6.1 Knowledge profile of the graduate

The content of the educational programme when analysed by knowledge area shall not fall below the minimum credits in each knowledge area as listed below.

Table 1: Minimum credits in knowledge areas	
Total	140
Mathematical Sciences	7
Natural Sciences	14
Engineering Sciences	42
Engineering Design & Synthesis	28
Computing and IT	7
Complementary Studies	7
Available for re-allocation in above areas	35

Credits available for reallocation must be assigned to the knowledge areas to form a coherent, balanced programme.

The method of calculation of credits and allocation to knowledge areas is defined in ECSA document E-01-P and Appendix A.

6.2 Core and specialist requirements

The programme shall have a coherent core of mathematics, basic sciences and fundamental engineering sciences that provides a viable platform for further studies and lifelong learning. The coherent core must enable development in a traditional discipline or in an emerging field. The coherent core includes fundamental elements. The provider may allow elective credits, subject to the minimum credits in each knowledge area and the exit level outcomes being satisfied for all choices.

A programme shall contain specialist engineering study at the exit level. Specialist study may lead to elective or compulsory credits. Specialist study may take on many forms including further deepening of a theme in the core, a new sub-discipline, or a specialist topic building on the core. It is recognized that the extent of specialist study is of necessity limited in view of the need to provide a substantial coherent core. Specialist study may take the form of compulsory or elective credits.

In the Complementary Studies area, it covers those disciplines outside of engineering sciences, basic sciences and mathematics which are relevant to the practice of engineering in two ways: (a) principles, results and method are applied in the practice of engineering, including engineering economics, the impact of technology on society and effective communication; and (b) study broadens the student's perspective in the humanities or social sciences to support an understanding of the world. Underpinning Complementary Studies knowledge of type (b) must be sufficient and appropriate to support the student in satisfying Exit Level Outcomes 7 and 10 in the graduates specialized practice area.

6.3 Curriculum Content

This standard does not specify detailed curriculum content. The fundamental and specialist engineering science content must be consistent with the designation of the Degree

7. Access to Qualification

This standard is specified as a set of exit level outcomes and overall distribution of credits. Providers therefore have the freedom to construct programmes geared to different levels of preparedness of learners, including:

- Use of access programmes for learners who do not meet the minimum requirements;
- Creating articulation pathways from other qualifications.

8. Minimum Learning Assumed to be in Place

It is assumed that students have completed a Bachelor of Engineering Technology or Advanced Diploma in Engineering or a substantially equivalent qualification.

9. EXIT LEVEL OUTCOMES

Exit Level Outcomes defined below are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulated practice environment. Words and phrases having specific meaning are defined in this document or in the ECSA document E-01-P.

Notes:

1. For Critical Cross-field Outcomes linked to Exit Level Outcomes refer to normative information in Appendix B. For exemplified informative associated assessment criteria, refer to Appendix C
2. The Level Descriptor: *Complex engineering problems* applicable to this Qualification Standard is characterised by:

a) require in-depth fundamental and specialized engineering knowledge;
and have one or more of the characteristics:
b) are ill-posed, under- or over specified, or require identification and refinement;
c) are high-level problems including component parts or sub-problems;
d) are unfamiliar or involve infrequently encountered issues;
and their solution have one or more of the characteristics:
e) are not obvious, require originality or analysis based on fundamentals;
f) are outside the scope of standards and codes;
g) require information from variety of sources that is complex, abstract or incomplete;
h) involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

Exit Level Outcome 1: Problem Solving

Demonstrate competence to identify, formulate, analyse and solve complex engineering problems creatively and innovatively.

Range Statement: Engineering problems are characterized by some or all of the following attributes:

- Problems require identification and analysis, and may be concrete or abstract, may be divergent and may involve significant uncertainty.
- Problems may be infrequently encountered types and occur in unfamiliar contexts.
- Approach to problem solving needs to be found, is creative and innovative.
- Information is complex and possibly incomplete, requiring validation and critical analysis.
- Solutions are based on theory, use of first principles and evidence, (which may be incomplete) together with judgment where necessary.
- Involves a variety of interactions which may impose conflicting constraints, premises, assumptions and / or restrictions.

Exit Level Outcome 2: Application of Scientific and Engineering Knowledge.

Demonstrate competence to apply knowledge of mathematics, natural science and engineering sciences to the conceptualization of engineering models and to solve complex engineering problems.
Range Statement: Knowledge of mathematics, natural science and engineering sciences is characterized by:

- A knowledge of mathematics using formalism, and oriented toward engineering analysis and modeling; deep knowledge of natural sciences: both as relevant to discipline.
- A deep knowledge of a broad range of fundamental principles of an engineering discipline or cross-disciplinary field that is coherently and systematically organized.
- In-depth, theoretically based knowledge in limited specialist area(s), informed by current developments, and emerging issues.
- The use of mathematics, naturals science and engineering sciences in formal analysis and modeling of engineering situations, for reasoning about and conceptualizing complex engineering problems.

Note: Problems used for assessment may provide evidence in the application of one, two or all three categories of knowledge listed above. It also requires working across engineering disciplinary boundaries through cross disciplinary literacy and shared fundamental knowledge.

Exit level Outcome 3: Engineering Design.

Demonstrate competence to perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes of a complex nature.

Range Statement: Design problems used in assessment must conform to the definition of a complex engineering problem.

- A major design problem should be used to provide a body of evidence that demonstrates this outcome.
- The problem would be typical of that which the graduate would participate in a typical employment situation shortly after graduation.

The selection of components, systems, engineering works, products or processes to be designed is dependent on the discipline or sub-discipline.

Exit Level Outcome 4: Investigations, Experiments and Data Analysis.

Demonstrate competence to conduct investigations of complex engineering problems including engagement with the research literature and use of research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

Range Statement This qualification includes conducting and reporting research under supervision, worth at least 30 credits, in the form of a discrete research component that is appropriate to the discipline or field of study. The following needs to be noted:

- The balance of investigation and experiment should be appropriate to the discipline.
- An investigation or experimental study should be typical of those in which the graduate would participate in an employment situation shortly after graduation.

Note: An investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon.

Exit Level Outcome 5: Engineering Methods, Skills and Tools, Including Information Technology.

Demonstrate competence to use appropriate techniques, resources, and modern engineering tools, including information technology, prediction and modeling, for the solution of complex engineering problems, with an understanding of the limitations, restrictions, premises, assumptions and constraints.

Range Statement: A range of methods, skills and tools appropriate to the discipline of the program including:

- Discipline-specific tools, processes or procedures;
- Computer packages for computation, modeling, simulation, and information handling;
- Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork;
- Techniques from economics, management, and health, safety and environmental protection.

Exit Level Outcome 6 Professional and Technical Communication.

Demonstrate competence to communicate effectively, both orally and in writing, with engineering audiences and the community at large.

Range Statement: Material to be communicated is in an academic or simulated professional context.

- Audiences range from engineering peers, related engineering personnel and lay persons.
- Appropriate academic or professional discourse is used.

Methods of providing information include the conventional methods of the discipline, for example engineering drawings, as well as subject-specific methods

Exit Level Outcome 7: Impact of Engineering Activity.

Demonstrate knowledge and understanding of the impact of engineering activities on: society, economy, industrial and physical environment.

Range Statement The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the discipline of the qualification. Evidence may include case studies typical of engineering practice situations in which the graduate is likely to participate. Issues, risks and impacts to be addressed:

- Could be outside of standards and codes of practice.
- Involve a diverse group of stakeholders with widely varying needs.
- May have significant consequences that are far-ranging.

Exit Level Outcome 8: Individual, Team and Multidisciplinary Working.

Demonstrate knowledge and understanding of engineering management principles.

Range Statement:

- May apply to one's own work, as a member or leader in a multidisciplinary project.
- The ability to manage a project should be demonstrated in the form of project indicated in ELO 3 and 4
- Tasks may require co-operation across at least one disciplinary boundary.

Co-operating disciplines may be engineering disciplines other than that of the programme or may be outside engineering.

Exit Level Outcome 9: Independent Learning Ability.

Demonstrate competence to engage in independent and life-long learning through well developed learning skills.

Range Statement: The learning context is complex and ill defined. Information is also drawn from research literature.

Exit Level Outcome 10: Engineering Professionalism.

Comprehend and apply ethical principles and commit to professional ethics, responsibilities and norms of engineering practice.

Range Statement: Evidence includes case studies typical of engineering practice situations in which the graduate is likely to participate.

10. International Comparability

International comparability of engineering education qualifications is ensured through the Washington, Sydney and Dublin Accords, all being members of the International Engineering Alliance (IEA).

The exit level outcomes and level descriptors defined in this qualification are aligned with the attributes of the International Engineering Alliance's Graduate Attributes and professional Competencies (See www.ieagreements.org).

11. Integrated Assessment

Providers of programmes shall in the quality assurance process demonstrate that an effective integrated assessment strategy is used. Clearly identified components of assessment must address summative assessment of the exit level outcomes. Evidence should be derived from major work or multiple instances of limited scale work.

12. Recognition of Prior Learning

Recognition of prior learning (RPL) may be used to demonstrate competence for admission to this programme. This qualification may be achieved in part through recognition of prior learning processes. Credits achieved by RPL must not exceed 50% of the total credits and must not include credits at the exit level.

13. Articulation Possibilities

A Bachelor Honours Degree is a requirement for admission to a Masters Degree or Postgraduate Diploma. A qualification may not be awarded for early exit from a Bachelor Honours Degree.

14. Moderation and Registration of Assessors

Providers of programmes shall in the quality assurance process demonstrate that an effective moderation process exists to ensure that the assessment system is consistent and fair.

Registration of assessors is delegated by the Higher Education Quality Committee to the Higher Education providers responsible for programmes.

Appendix A: Method of Calculation of Credits and Allocation to Knowledge Area.

The method of calculation assumes that certain activities are scheduled on a regular weekly basis while others can only be quantified as a total activity over the duration of a course or module. This calculation makes the following assumptions:

1. Classroom or other scheduled contact activity generates notional hours of the student's own time for each hour of scheduled contact. The total is given by a multiplier applied to the contact time.
2. Two weeks of full-time activity accounts for assessment in a semester.
3. Assigned work generates only the notional hours judged to be necessary for completion of the work and is not multiplied.

Define for each course or module identified in the rules for the Degree: Type of Activity, Time Unit in Hours and Contact Time Multiplier

The credit for the course is: $C = \{W (L*TL *ML + T*TT *MT) + P*TP *MP + X*TX *MX + A*TA \}/10$

Where:

L	= number of lectures per week,
TL	= duration of a lecture period
ML	= total work per lecture period
T	= number of tutorial per week
TT	= duration of a tutorial period
MT	= total work per tutorial period
P	= total practical periods
T	= duration of a practical period
MP	= total work per practical period
X	= total other contact periods
TX	= duration of other period
MX	= total work per other period
A	= total assignment non-contact Hours
TA	= 1 hour
W	= number of weeks the course lasts (actual + 2 week per semester for examinations, if applicable to the course or module)

The resulting credit for a course or value may be divided between more than one knowledge areas. In allocating the credit for a course to multiple knowledge areas, only new knowledge or skills in a particular area may be counted. Knowledge and skills developed in other courses and used in the course in question shall not be counted. Such knowledge is classified by the nature of the area in which it is applied. In summary, no knowledge is counted more than once as being new.

Appendix B: Consistency of Exit Level Outcomes with Critical Crossfield Outcomes (Normative)

SAQA Critical Cross-Field Outcomes	Equivalent Exit Level Outcome
Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.	ELO 1.2.3.5
Working effectively with others as a member of a team, group, organisation and community.	ELO 8
Organising and managing oneself and one's activities responsibly and effectively	ELO 3,4, 8
Collecting, analysing, organising and critically evaluating information.	ELO 1, 3,4, 5
Communicating effectively using visual, mathematical and/or language skills	ELO1, 2,3,4, 6
Using science and technology effectively and critically, showing responsibility toward the environment and health of others	ELO 2, 3, 4, 5, 7
Demonstrating an understanding of the world as a set of related systems by recognising that problem context do not exist in isolation	ELO 1, 3,7
Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of:	
• reflecting on and exploring a variety of strategies to learn more effectively	ELO 9
• participating as responsible citizens in the life of local, national and global communities	ELO 7, 10
• being culturally and aesthetically sensitive across a range of contexts	ELO 7
• exploring education and career opportunities	ELO 8
• developing entrepreneurial opportunities	ELO 3

Appendix C: Exemplified Associated Assessment Criteria

The assessment criteria presented here are typifying, not normative.

Exit Level Outcome 1:

1.1 The problem is analysed and defined and criteria are identified for an acceptable solution.
1.2 Relevant information and engineering knowledge and skills are identified for solving the problem.
1.3 Possible approaches are generated and formulated that would lead to a workable solution for the problem.
1.4 Possible solutions are modelled and analysed.
1.5 Possible solutions are evaluated and the best solution is selected.
1.6 The solution is formulated and presented in an appropriate form.

Exit Level Outcome 2:

2.1 An appropriate mix of knowledge of mathematics, numerical analysis, statistics, natural science and engineering science at a fundamental level and in a specialist area is brought to bear on the solution of *complex* engineering problems.
2.2 Theories, principles and laws are used.
2.3 Formal analysis and modelling is performed on engineering materials, components, systems or processes.
2.4 Concepts, ideas and theories are communicated.
2.5 Reasoning about and conceptualising engineering materials, components, systems or processes is performed.
2.6 Uncertainty and risk is handled.
2.7 Work is performed within the boundaries of the practice area.

Exit Level Outcome 3:

3.1 The design problem is formulated to satisfy user needs, applicable standards, codes of practice and legislation.
3.2 The design process is planned and managed to focus on important issues and recognises and deals with constraints.
3.3 Knowledge, information and resources are acquired and evaluated in order to apply appropriate principles and design tools to provide a workable solution.
3.4 Design tasks are performed including analysis, quantitative modelling and optimisation of the product, system or process subject to the relevant premises, assumptions, constraints and restrictions.
3.5 Alternatives are evaluated for implementation and a preferred solution is selected based on techno-economic analysis and judgement.
3.6 The selected design is assessed in terms of the social, economic, legal, health, safety, and environmental impact and benefits.
3.7 The design logic and relevant information is communicated in a technical report.

Exit Level Outcome 4:

4.1 Investigations and experiments are planned and conducted within an appropriate discipline.
4.2 Available literature is searched and material is critically evaluated for suitability to the investigation.
4.3 Analysis is performed as necessary to the investigation.
4.4 Equipment or software is selected and used as appropriate in the investigations.

4.5 Information is analysed, interpreted and derived from available data.
4.6 Conclusions are drawn from an analysis of all available evidence.
4.7 The purpose, process and outcomes of the investigation are recorded in a technical report or research project report

Exit Level Outcome 5:
5.1 The method, skill or tool is assessed for applicability and limitations against the required result.
5.2 The method, skill or tool is applied correctly to achieve the required result.
5.3 Results produced by the method, skill or tool are tested and assessed against required results.
5.4 Computer applications are created, selected and used as required by the discipline

Exit Level Outcome 6:
6.1 The structure, style and language of written and oral communication are appropriate for the purpose of the communication and the target audience.
6.2 Graphics used are appropriate and effective in enhancing the meaning of text.
6.3 Visual materials used enhance oral communications.
6.4 Accepted methods are used for providing information to others involved in the engineering activity.
6.5 Oral communication is delivered fluently with the intended meaning being apparent.

Exit Level Outcome 7:
7.1 The impact of technology is explained in terms of the benefits and limitations to society.
7.2 The engineering activity is analysed in terms of the impact on public and occupational health and safety.
7.3 The engineering activity is analysed in terms of the impact on the physical environment.
7.4 Personal, social, economic, cultural values and requirements are taken into consideration for those who are affected by the engineering activity.

Exit Level Outcome 8:
8.1 The principles of planning, organising, leading and controlling are explained.
8.2 Individual work is carried out effectively, strategically and on time.
8.3 Contributions to team activities, including at disciplinary boundaries, support the output of the team as a whole.
8.4 Functioning as a team leader is demonstrated.
8.5 A design or research project is organised and managed.
8.6 Effective communication is carried out in the context of individual or team work.

Exit Level Outcome 9:
9.1 Learning tasks are managed autonomously and ethically, individually and in learning groups.
9.2 Learning undertaken is reflected on and own learning requirements and strategies are determined to suit personal learning style and preferences.
9.3 Relevant information is sourced, organised and evaluated
9.4 Knowledge acquired outside of formal instruction is comprehended and applied.
9.5 Assumptions are challenged critically and new thinking is embraced

Exit Level Outcome 10:
10.1 The nature and complexity of ethical dilemmas is described.
10.2 The ethical implications of decisions made are described.

10.3 Ethical reasoning is applied to evaluate engineering solutions.
10.4 Continued competence is maintained through keeping abreast of up-to-date tools and techniques available in the workplace.
10.5 The system of continuing professional development is understood and embraced as an on-going process.
10.6 Responsibility is accepted for consequences stemming from own actions.
10.7 Judgements are made in decision making during problem solving and design are justified.
10.8 Decision making is limited to area of current competence.

Revision History

Version	Date	Revision Authorized by	Nature of revision
Rev1	14 September 2012	Technology SGG Working Group	Reconfiguration of document approved by Council to align with E-02-PE