ECSA GRADUATE ATTRIBUTES

1. GRADUATE ATTRIBUTES

Document No. : E-02-PE, Revision 6 **Qualification Standard for Bachelor of Science in Engineering (BSc(Eng))/ Bachelors of Engineering (BEng): NQF Level 8.** ***Section 14 p.18-22***

1.1. Graduate Attribute 1 – Problem Solving

Identify, formulate, analyse and solve complex engineering problems

Question to be answered	Has the student identified, formulated, analysed and solved a complex engineering problem creatively and innovatively on page 4
Types of evidence	• Identification and refinement of ill-posed or under/over -specified problems, involving wide-ranging or conflicting issues. • Contextualisation of problem in terms of literature, global economic and technological trends, government imperatives, significance to society, etc. • Solving problems that consist of sub-problems or involving infrequently encountered or unfamiliar issues. • Solutions have these characteristics: are not obvious, require originality or analysis based on fundamentals, require information from a variety of sources.

1.2. Graduate Attribute 2 – Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural sciences, engineering fundamentals and an engineering speciality to solve complex engineering problems

Question to be answered	Has the student applied knowledge of mathematics, natural sciences, engineering fundamentals and an engineering speciality to solve complex engineering problems on page 4?
Types of evidence	• Mathematics, natural science and engineering sciences are applied in formal analysis and modelling of engineering situations, and for reasoning about and conceptualising engineering problems. • A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. • Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. • A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline. • Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline, much of which is at the forefront of the discipline.

1.3. Graduate Attribute 3 – Engineering design

Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes.

Question to be answered	Has the student demonstrated competence to performed creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes?
Types of evidence	• A major design problem should be used to provide evidence. • The design knowledge base and components, systems, engineering works, products or processes to be designed are dependent on the discipline or practice area. • The use of formal engineering design procedures and methods for the design of components, systems or processes. The use of formal concept generation and selection tools and methods. • The use of design tools, e.g. QFD etc. • The documentation of designs using CAD, function breakdown diagrams and assembly precedence diagrams. • The application of Design for X principles. • Appropriate consideration must be given to public health and safety, whole-life cost and net zero carbon, as well as resource, cultural, societal and environmental considerations, as required.

1.4. Graduate Attribute 4 – Investigations, experiments and data analysis	
Demonstrate competence to design and conduct investigations and experiments.	
Question to be answered	Has the student demonstrated competence to design and conduct investigations and experiments?
Types of evidence	• Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues. • The balance of investigation and experiment should be appropriate to the discipline. • Research methodology is to be applied in research or an investigation where the student engages with selected knowledge in the research literature of the discipline.
1.5. Graduate Attribute 5 – Engineering methods, skills and tools, including information technology	
Demonstrate competence to use appropriate engineering methods, skills and tools, including those based on information technology.	
Question to be answered	Has the student demonstrated competence to use appropriate engineering methods, skills and tools, including those based on IT?
Types of evidence	• Use of discipline-specific tools, processes or procedures. • Use of computer packages for computation, modelling, simulation, and information handling (e.g. CAD, FEA, CFD, MATLAB, Mathematica, etc.). • Use of computers, networks and information infrastructures to enhance personal productivity and teamwork. • Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. • Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. • A range of techniques, resources and modern engineering and IT tools appropriate to the disciplinary designation of the programme
1.6. Graduate Attribute 6 – Professional and technical communication	
Demonstrate competence to communicate effectively, both orally and in writing, with engineering audiences and the community at large.	
Question to be answered	Has the student demonstrated competence to communicate effectively in writing and orally?
Types of evidence	• Conventional methods of the discipline (e.g. CAD Drawings). • Subject-specific communication methods (e.g. Graphical Techniques). • Logical construction of dissertation. • Professional and concise written communication. • Use of appropriate technical terminology. • Competent use of grammar, spelling and punctuation. • Use of formal referencing standards. • Ethical conduct in the use of reference materials
1.7. Graduate Attribute 7 – Sustainability and impact of engineering activity	
Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment.	
Question to be answered	Has the student demonstrated critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment?
Types of evidence	• The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the discipline or other designation of the qualification. • Comprehension of the role of engineering in the world and identified issues in engineering practice in the discipline: health, safety and environmental protection, risk assessment and management, and the impacts of engineering activity: economic, social, cultural, environmental and sustainability. • Identifying issues in engineering design that relate to health, safety, environmental protection, risk assessment and management. • Analysing the sustainability and impact of engineering designs on the economic, social, cultural, environmental domains. • A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. • Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon and similar concepts, that supports engineering design and operations in a practice area.

	• Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
1.8. Graduate Attribute 8 – Individual, team and multidisciplinary working	
Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.	
Question to be answered	Has the student demonstrated competence to work effectively as an individual, in teams and in multidisciplinary environments?
Types of evidence	• Multi-disciplinary tasks require co-operation across at least one disciplinary boundary. • Co-operating disciplines may be engineering disciplines with different fundamental bases other than that of the programme or may be outside engineering. • The work of each group member is coherent with work of other team members. • There is a clear distinction between the work done by individuals and that of the group as a whole. • Student has made an appropriate individual contribution to the project. • Multidisciplinary work with professionals outside of the discipline of mechanical engineering have provided significant technical insights
1.9. Graduate Attribute 9 – Independent learning ability	
Demonstrate competence to engage in independent learning through well-developed learning skills.	
Question to be answered	Has the student demonstrated competence to engage in independent learning through well-developed learning skills?
Types of evidence	• Operating independently in complex, ill-defined contexts requiring personal responsibility and initiative. • Insightful engagement with literature from advanced academic sources. • Acquisition and application of new knowledge, skills and insights outside of formal instruction and without direct supervision. • Awareness of social and ethical implications of applying knowledge in particular contexts. • Operate independently in complex contexts recognising the need for and having the preparation and ability for i. independent and life-long learning, ii. adaptability to new and emerging technologies, iii. critical thinking in the broadest context of technological change.
1.10. Graduate Attribute 10 – Engineering professionalism	
Demonstrate critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence.	
Question to be answered	Has the student demonstrated critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence?
Types of evidence	• Knowledge of professional ethics, responsibilities and norms of engineering practice. • Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.
1.11. Graduate Attribute 11 – Engineering management	
Demonstrate knowledge and understanding of engineering management principles and economic decision-making.	
Question to be answered	Has the student demonstrated knowledge and understanding of engineering management principles and economic decision-making?
Types of evidence	• Application of basic techniques from economics, business management and project management applied to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. • Critical reflection on individual and group progress. • Critical reflection on individual and group management practice during engineering activities. • Critical reflection and evaluation of achievements, outputs, measures of success and stakeholder satisfaction. • Use of project management tools: Gantt or PERT charts, meeting minutes, organograms, responsibility matrices, budgets, budget performance reports, etc.

GRADUATE ATTRIBUTES

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The Graduate Attributes 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 and in ECSA document E01 POL.

General range statement:

The competencies defined in the 11 graduate attributes may be demonstrated in a university based, simulated workplace context. Competencies stated generically may be assessed in various engineering disciplinary or cross disciplinary contexts.

Level descriptor: Complex engineering problems

a) require in-depth fundamental and specialized engineering knowledge; and have one or more of the characteristics:

i. are ill-posed, under- or over specified, or require identification and refinement.

ii. are high-level problems including component parts or sub-problems;

iii. are unfamiliar or involve infrequently encountered issues;

b) and their solutions have one or more of the characteristics:

i. are not obvious, require originality or analysis based on fundamentals;

ii. are outside the scope of standards and codes;

iii. require information from variety of sources that is complex, abstract or incomplete;

iv. involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

Graduate Attribute 1: Problem-solving

Identify, formulate, analyse and solve complex engineering problems

Graduate Attribute 2: Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural sciences, engineering fundamentals and an engineering speciality to solve complex engineering problems

Level descriptor: *Knowledge of mathematics, natural sciences and engineering sciences is characterized by:*

- A systematic, theory-based understanding of the natural sciences applicable to the discipline;
- Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline;
- A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline; and
- Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

Range statement:

Mathematics, natural science and engineering sciences are applied in formal analysis and modelling of engineering situations, and for reasoning about and conceptualising engineering problems.

Graduate Attribute 3: Engineering design

Perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes.

Range statement:

Design problems used in exit-level assessment must conform to the definition of a complex engineering problem. A major design problem should be used to provide evidence. The design knowledge base and components, systems, engineering works, products or processes to be designed are dependent on the discipline or practice area

Graduate Attribute 4: Investigations, experiments and data analysis

Demonstrate competence to design and conduct investigations and experiments.

Range statement:

The balance of investigation and experiment should be appropriate to the discipline. Research methodology is to be applied in research or an investigation where the student engages with selected knowledge in the research literature of the discipline.

Note:

The balance of investigation and experiment should be appropriate to the discipline. Research methodology is to be applied in research or an investigation where the student engages with selected knowledge in the research literature of the discipline.

Graduate Attribute 5: Engineering methods, skills and tools, including information technology

Demonstrate competence to use appropriate engineering methods, skills and tools, including those based on information technology.

Range statement:

A range of methods, skills and tools appropriate to the disciplinary designation of the program including:

- Discipline-specific tools, processes or procedures;
- Computer packages for computation, modelling, simulation, and information handling;
- Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork.

Graduate Attribute 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, management and lay persons, using appropriate academic or professional discourse. Written reports range from short (300-1000 words plus tables diagrams) to long (10 000 to 15 000 words plus tables, diagrams and appendices), covering material at exit-level. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, as well as subject- specific methods.

Graduate Attribute 7: Sustainability and impact of engineering activity

Demonstrate critical awareness of the sustainability and impact of engineering activity on the social, industrial and physical environment.

Range statement:

The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the discipline or other designation of the qualification. Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: health, safety and environmental protection; risk assessment and management and the impacts of engineering activity: economic, social, cultural, environmental and sustainability.

Graduate Attribute 8: Individual, team and multidisciplinary working

Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

Range statement:

Multidisciplinary tasks require co-operation across at least one disciplinary boundary. Co-operating disciplines may be engineering disciplines with different fundamental bases other than that of the programme or may be outside engineering.

Graduate Attribute 9: Independent learning ability

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

Range statement:

Operate independently in complex, ill-defined contexts requiring personal responsibility and initiative, accurately self-evaluate and take responsibility for learning requirements; be aware of social and ethical implications of applying knowledge in particular contexts.

Graduate Attribute 10: Engineering professionalism

Demonstrate critical awareness of the need to act professionally and ethically and to exercise judgment and take responsibility within own limits of competence.

Range statement:

Evidence includes case studies typical of engineering practice situations in which the graduate is likely to participate. Ethics and the professional responsibility of an engineer and the contextual knowledge specified in the range statement of Graduate Attribute 7 is generally applicable here.

Graduate Attribute 11: Engineering management
Demonstrate knowledge and understanding of engineering management principles and economic decision-making.
Range statement:
Basic techniques from economics, business management; project management applied to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.