Excerpt from:

ENGINEERING COUNCIL OF SOUTH AFRICA
Standards and Procedures System
Qualification Standard for Bachelor of Science in Engineering
(BSc(Eng))/Bachelors of Engineering (BEng): NQF Level 8;
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13. 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 ECSA Document E-01-P [1].

General Range Statement: The competencies defined in the eleven exit-level outcomes 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;
b) and have one or more of the characteristics:
c) are ill-posed, under- or overspecified, or require identification and refinement;
d) are high-level problems including component parts or sub-problems;
e) are unfamiliar or involve infrequently encountered issues;
f) and their solutions have one or more of the characteristics:
g) are not obvious, require originality or analysis based on fundamentals;
h) are outside the scope of standards and codes;
i) require information from variety of sources that is complex, abstract or incomplete;
j) involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

Exit-level Outcome 1: Problem solving

Identify, formulate, analyse and solve complex engineering problems creatively and innovatively.

Exit-level Outcome 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 conceptualizing engineering problems.

Exit-level Outcome 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.

Exit-level Outcome 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 to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline.

Note: An investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.

Exit-level Outcome 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:

1. Discipline-specific tools, processes or procedures;

2. Computer packages for computation, modelling, simulation, and information handling;

3. Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork.

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, 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.

Exit-level Outcome 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.

Exit-level Outcome 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.

Exit-level Outcome 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.

Exit-level Outcome 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 Exit Level outcome 7 is generally applicable here.

Exit-level Outcome 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