1. Introduction

The EUR-ACE® Standards and Guidelines for Accreditation of Engineering Programmes (EAFSG) are described here in terms of Student Workload Requirements (Sect 2), Programme Outcomes (Sect. 3) and Programme Management (Sect. 4).

The Student Workload Requirements and the Programme Outcomes are compliant with the overarching Framework of Qualifications for the European Higher Education Area (EQF), adopted by the Bergen Conference of European Ministers responsible for Higher Education on 19-20 May 2005. The framework "comprises three cycles (including, within national contexts, the possibility of intermediate qualifications), generic descriptors for each cycle based on learning outcomes, and credit ranges in the first and second cycles".

The overall result of the application of the EQF is a range of Bachelor and Master Degree programmes in engineering now offered in European Higher Education Institutions. These are described here in terms of the European Credit Transfer System as follows:

a) Fulltime Bachelor degree programmes in engineering are now of 180, 210 or 240 ECTS credits.

b) Fulltime Master degree programmes in engineering are of 60, 90 or 120 ECTS credits.

As established by the "Recommendation of the European Parliament and of the Council" of 23 April 2008, the descriptor for the first cycle in the Framework for Qualifications of the European Higher Education Area (Bologna process) corresponds to the learning outcomes for the EQF, level 6. The descriptor for the second cycle in the Framework for Qualifications of the European Higher Education Area corresponds to the learning outcomes for the EQF, level 7.

The Programme Outcomes are consistent with the provisions of the EQF.

The Programme Management requirements are consistent with the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), adopted by the 2005 Bergen Conference of European Ministers responsible for Higher Education.

2. Student Workload Requirements

The workload requirements are described using ECTS credits.

ENAEE describes the Programme Outcomes for Bachelor and Master Degree programmes normally structured as follows:

Bachelor Degree programmes, of a minimum of 180 ECTS credits.

Master Degree programmes, of a minimum of 90 ECTS credits (60 in some educational systems).

Master Degree programmes which are integrated and which, normally, do not include the award of a Bachelor Degree, should comprise ECTS credits consistent with the above: i.e. a minimum of 270 ECTS credits (240 in some education systems).

3. Programme Outcomes Framework

(a) Programme Outcomes describe the knowledge, understanding, skills and abilities which an accredited engineering degree programme must enable a graduate to demonstrate. The Programme Outcomes specified below apply to accredited programmes which are to be awarded a EUR-ACE label by an authorised agency. In this document, the term learning outcome is used only to describe the knowledge, understanding, skills and abilities which apply to individual course units/modules.

(b) The Programme Outcomes specified in this document are intended to be applicable to the full range of Bachelor and Master Degree programmes in engineering offered in European HEI's. They have to be considered as the 'minimum threshold' defined by the ENAEE community and to be fulfilled in order to assure the quality of engineering programmes.

(c) The Programme Outcomes can be used in both the design (by engineering academics) and the evaluation (by accreditation agencies) of programmes in all branches of engineering and for different profiles.

(d) The standards describe the Programme Outcomes that accredited programmes must meet, but do not prescribe how they are realised. Consequently, no restriction is implied or intended by the EAFSG in the design of programmes to meet the specified Programme Outcomes. HEI's retain the freedom to formulate programmes with an individual emphasis and character, including new and innovative programmes, and to prescribe conditions for entry into each programme.

(e) The Programme Outcomes are described here separately for both Bachelor and Master Degree programmes with reference to the following eight learning areas:

Knowledge and understanding;

Engineering Analysis;

Engineering Design;

Investigations;

Engineering Practice;

Making Judgements;

Communication and Team-working;

Lifelong Learning.

(f) The ENAEE/IEA Glossary of Terminology is used to verify terms used in this document.

(g) The learning area descriptors may be adopted by an Authsorised Agency or adapted to accommodate the local context and any specific requirements. In the latter case there should be close alignment with the EURACE Descriptors.

3.1 Programme Outcomes for Bachelor Degree Programmes

Knowledge and Understanding

The learning process should enable Bachelor Degree graduates to demonstrate:

- knowledge and understanding of the mathematics, computing and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes;
- knowledge and understanding of engineering fundamentals underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront;
- awareness of the wider multidisciplinary context of engineering.

Engineering Analysis

The learning process should enable Bachelor Degree graduates to demonstrate:

- ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses;
- ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical –societal, health and safety, environmental, economic and industrial – constraints.

Engineering Design

The learning process should enable Bachelor Degree graduates to demonstrate:

- ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness

of non-technical – societal, health and safety, environmental, economic and industrial– considerations; to select and apply relevant design methodologies;

- ability to design using an awareness of the forefront of their engineering specialisation.

Investigations

The learning process should enable Bachelor Degree graduates to demonstrate:

- ability to conduct searches of literature, to consult and to critically use scientific databases and other appropriate sources of information, to carry out simulation and analysis in order to pursue detailed investigations and research of technical issues in their field of study;
- ability to consult and apply codes of practice and safety regulations in their field of study;
- laboratory/workshop skills and ability to design and conduct experimental investigations, interpret data and draw conclusions in their field of study.

Engineering Practice

The learning process should enable Bachelor Degree graduates to demonstrate:

- understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study;
- practical skills for solving complex problems, realising complex engineering designs and conducting investigations in their field of study;
- understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations in their field of study;
- ability to apply norms of engineering practice in their field of study;
- awareness of non-technical -societal, health and safety, environmental, economic and industrial – implications of engineering practice;
- awareness of economic, organisational and managerial issues (such as project management, risk and change management) in the industrial and business context.

Making Judgements Communication and Team-working

The learning process should enable Bachelor Degree graduates to demonstrate:

- ability to gather and interpret relevant data and handle complexity within their field of study, to inform judgements that include reflection on relevant social and ethical issues;
- ability to manage complex technical or professional activities or projects in their field of study, taking responsibility for decision making.

Lifelong Learning

The learning process should enable Bachelor Degree graduates to demonstrate:

- ability to recognise the need for and to engage in independent life-long learning;ability to follow developments in science and technology.

3.2 Programme Outcomes for Master Degree Programmes

Knowledge and Understanding

The learning process should enable Master Degree graduates to demonstrate:

- in-depth knowledge and understanding of mathematics, computing and sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes;
- in-depth knowledge and understanding of engineering disciplines underlying their specialisation, at a level necessary to achieve the other programme outcomes;
- critical awareness of the forefront of their specialisation;
- critical awareness of the wider multidisciplinary context of engineering and of knowledge issues at the interface between different fields.

Engineering Analysis

The learning process should enable Master Degree graduates to demonstrate:

- ability to analyse new and complex engineering products, processes and systems within broader or multidisciplinary contexts; to select and apply the most appropriate and relevant methods from established analytical, computational and experimental methods or new and innovative methods; to critically interpret the outcomes of such analyses;
- ability to conceptualise engineering products, processes and systems;
- ability to identify, formulate and solve unfamiliar complex engineering problems that are incompletely defined, have competing specifications, may involve considerations from outside their field of study and non-technical – societal, health and safety, environmental, economic and industrial – constraints; to select and apply the most appropriate and relevant methods from established analytical, computational and experimental methods or new and innovative methods in problem solving;
- ability to identify, formulate and solve complex problems in new and emerging areas of their specialisation.

Engineering Design

The learning process should enable Master Degree graduates to demonstrate:

- ability to develop, to design new and complex products (devices, artefacts, etc.), processes and systems, with specifications incompletely defined and/or competing, that require integration of knowledge from different fields and non-technical – societal, health and safety, environmental, economic and industrial commercial – constraints; to select and apply the most appropriate and relevant design methodologies or to use creativity to develop new and original design methodologies.
- ability to design using knowledge and understanding at the forefront of their engineering specialisation.

Investigations

The learning process should enable Master Degree graduates to demonstrate:

- ability to identify, locate and obtain required data;
- ability to conduct searches of literature, to consult and critically use databases and other sources of information, to carry out simulation in order to pursue detailed investigations and research of complex technical issues;
- ability to consult and apply codes of practice and safety regulations;
- advanced laboratory/workshop skills and ability to design and conduct experimental investigations, critically evaluate data and draw conclusions;
- ability to investigate in a creative way the application of new and emerging technologies at the forefront of their engineering specialisation.

Engineering Practice

The learning process should enable Master Degree graduates to demonstrate:

- comprehensive understanding of applicable techniques and methods of analysis, design and investigation and of their limitations;
- practical skills, including the use of computer tools, for solving complex problems, realising complex engineering design, designing and conducting complex investigations;
- comprehensive understanding of applicable materials, equipment and tools, engineering technologies and processes, and of their limitations;
- ability to apply norms of engineering practice;
- knowledge and understanding of the non-technical – societal, health and safety, environmental, economic and industrial – implications of engineering practice;
- critical awareness of economic, organisational and managerial issues (such as project management, risk and change management)

Making Judgement Skills Communication and Team-working Skills

The learning process should enable Master Degree graduates to demonstrate:

- ability to integrate knowledge and handle complexity, to formulate judgements with incomplete or limited information, that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgement to deliver sustainable solutions for society, the economy and environment;
- ability to manage complex technical or professional activities or projects that can require new strategic approaches, taking responsibility for decision making.

Lifelong Learning Skills

The learning process should enable Master Degree graduates to demonstrate:

- ability to engage in independent life-long learning;
- ability to undertake further study autonomously.

4. Programme management

(a) Accreditation agencies should confirm that engineering degree programmes, for which an HEI seeks accreditation, are managed to,

- achieve the programme aims;
- provide a teaching and learning process that enables students to demonstrate achievement of Programme Outcomes;
- provide adequate resources;
- monitor the rules for student admission, transfer, progression and graduation;

and

- comply with internal quality assurance procedures.

b) The five standards below specify the key areas of programme management that must be evaluated if an agency is to be authorised to award the EUR-ACE® label. The guidelines that follow the standards are not prescriptive but are intended to assist agencies and HEIs in meeting the standards. Programme managers are free to satisfy the standards in accordance with their own traditions and resources.

4.1 Programme Aims

The aims of accredited programmes must reflect the needs of employers and other stakeholders. The programme outcomes must be demonstrably consistent with the aims.

The aims should take into account employment opportunities for graduates, potential developments in technology, the needs of employers, the wide range of applications of engineering, postgraduate opportunities for graduates, the mission of the university and the interests of students.

4.2 Teaching and Learning Process

The teaching and learning process must enable engineering graduates to demonstrate the knowledge, understanding, skills and abilities specified in the Programme Outcomes. The programme curriculum must specify how this is to be achieved.

The curriculum should give comprehensive information on all the modules in the degree programme, including the syllabus, the module learning outcomes, the methodology of teaching and learning, credit allocation, the method of module assessment, and any pre-requisite or co-requisite modules or other programme requirements. The curriculum should ensure that the module learning outcomes aggregate to the programme learning outcomes, including the effect of student choice of modules.

The learning process should be sufficiently flexible to accommodate different entry qualifications of students and different learning styles. If the programme includes time spent in industry or in another HEI, it should be assessed in the context of its contribution to the achievement of the Programme Outcomes.

The assessment of students should evaluate achievement of the specified module learning outcomes, and be both rigorous and fair. Wherever possible there should be the second marking of student work or moderation of assessments. Students should have an opportunity to redeem work that is assessed as being below standard, provided this can be done without compromising output standards.

Independent and external scrutiny of the assessment of students, and of the decisions on progress and completion, are effective in ensuring that output standards are maintained. The arrangements for any such scrutiny should be documented.

The design, delivery of online programmes should demonstrate achievement of the prescribed programme outcomes

4.3 Resources

The resources to deliver the programme must be sufficient to enable the students to demonstrate the knowledge, understanding, skills and abilities specified in the Programme Outcomes.

The number, qualifications and experience of the teaching staff should be adequate to teach the programme to the standard specified in the Programme Outcomes. The programme should be supported by an effective team of technical and administrative staff. There should be arrangements in place for ensuring that staff are updated to use and apply new technologies and receive training as and when required.

The laboratory, computing and workshop facilities should have the equipment necessary to support the programme; the arrangements for safe access by students should ensure appropriate opportunities for student practical activities, particularly to support project work.

Student support services, including but not limited to, tutoring, library and other information resources, assistance with external placements, should be readily accessible by students.

The resources necessary to deliver the programme should be supported by an adequate budget.

For programmes delivered online the resources and technology supporting delivery should not disadvantage any party.

4.4 Student admission, transfer, progression and graduation

The criteria for student admission, transfer, progression and graduation must be clearly specified and published, and the results monitored.

Students should be informed of the qualifications necessary to enter the programme and of the regulations necessary to progress to completion. The criteria for students to transfer into later stages of the programme should be clearly specified.

Records of student achievement provide essential information for the review and development of programmes. There should be arrangements for monitoring the progress of students through the programme against their entry qualifications, so as to provide essential data for reviewing entry to the programme. In particular the number of, and reasons for, non-completions should be recorded. The overall performance of students in individual modules should be noted in order to identify assessment results that are significantly different from the norm.

4.5 Internal Quality Assurance

Accredited engineering degree programmes must be supported by effective quality assurance policies and procedures.

The programme should have quality assurance procedures that are consistent with the HEI quality assurance policy. It would be expected that there is a defined and documented procedure for reviewing the programme at regular intervals using all relevant data, including an evaluation of student achievement against the stated programme aims.

Feedback should be obtained in an agreed format from the students on an accredited programme on all taught modules in the programme, to enable the effectiveness of each module to be evaluated. There should be clearly understood arrangements for the day to day management of the programme to resolve any urgent and immediate problems.

Information about all aspects of the programme, including the quality assurance procedures, should be publicly available.

If HEIs have been subject of other quality assurance reviews the results of these reviews and any conditions addressed should be made available to the EUR-ACE review team.