



**Romanian Agency for Quality
Assurance in Higher Education**

**European Network for Accreditation
of Engineering Education**

STANDARDS AND GUIDELINES FOR EUR-ACE® CERTIFICATION OF STUDY PROGRAMMES IN FUNDAMENTAL FIELD ENGINEERING SCIENCES

1. Introduction

The standards and guidelines for EUR-ACE® certification of study programmes in the fundamental field Engineering Sciences are described below and envisage (i) the requirements regarding the volume of work done by the student (paragraph 2), (ii) results of study programme (paragraph 3) and (iii) organization and coordination of study programme (paragraph 4).

The requirements regarding the volume of work done by the student and the results of study programme are aligned to the Framework of Qualifications for the European Higher Education Area – EQF), adopted at the Ministerial Conference of Bergen, on 19-20 May 2005. The framework provides "three cycles" (including, in national context, the possibility of intermediary qualifications), generic descriptors for each cycle, based on learning outcomes and credits allotted in the first two cycles.

The global outcome of EQF application represents a series of bachelor's degree and master's degree study programmes in the fundamental field of Engineering Sciences, offered by the higher education institutions of Europe. In Romania, they are described, depending on the system of transferrable credits ECTS, as follows:

- a) Bachelor's degree programmes in fundamental field Engineering Sciences, with 240 credits ECTS.
- b) Master's degree programmes in the fundamental field Engineering Sciences, with 90 or 120 credits ECTS.

The organization and coordination of study programmes comply with the *Standards and Guidelines for quality assurance in European Higher Education Area* (European Standards and Guidelines – ESG), adopted for the first time at the Ministerial Conference of Bergen, with the revised version adopted at Ministerial Conference of Erevan, 14-15 May 2015.

2. Volume of work done by the student

The volume of work done by the student is described by credits ECTS.

ENAAE describes the outcomes of Bachelor's degree and Master's degree programmes as follows:

- Bachelor's degree programmes with minimum 180 credits ECTS;
- Master's degree programmes, with minimum 90 credits ECTS.



- integrated Master's degree programmes, which do not include the awarding of a Bachelor's degree must have minimum 270 credits ECTS.

3. Outcomes of study programme

- (a) The outcomes of study programme describe the competences under the form of knowledge and skills, which the graduate of an accredited study programme from the fundamental field of Engineering Sciences has to prove, and the study programme will be certified EUR-ACE® by ARACIS. In this document, the term *learning outcome* is used to describe the knowledge and skills characteristic of a certain subject of curriculum.
- (b) The outcomes of the study programme presented in this document must be interpreted as minimum thresholds defined by ENAEE community and must be fulfilled so as to assure the quality of study programmes in engineering.
- (c) The outcomes of study programme can be used both in the design (by universities) and in evaluation (by ARACIS) of study programmes in all the fields specific to Engineering Sciences.
- (d) ENAEE Standards describe the outcomes which must be obtained by the study programmes accredited and certified EUR-ACE®, but they do not provide the way in which this process is carried out. Therefore, ENAEE standards do not impose restrictions in the design of study programmes, in order to obtain the expected results. The higher education institutions reserve the freedom to propose specific programmes and to establish the conditions for admission.
- (e) We will describe below the outcomes of the study programme, separately, for bachelor's degree and master's degree, both categories make reference to eight learning areas:
 - knowledge and understanding;
 - engineering analysis;
 - engineering design;
 - research;
 - engineering practice;
 - formation of opinions;
 - communication and team work;
 - lifelong training.

3.1 Expected outcomes for Bachelor's degree programmes

- **Knowledge and understanding**

The Bachelor's degree graduates have to demonstrate:

- knowledge and understanding of mathematics notions and notions of other sciences on which the engineering specialty they graduated is based, at a sufficient level to develop also other competences defined as expected outcomes;

- knowledge and understanding of engineering subjects on which the specialization is based, at a sufficient level to develop also other competences defined as expected outcomes, including the awareness of close-up elements which define that specialization;
- awareness of the wider multidisciplinary context of engineering.

- **Engineering analysis:**

The Bachelor's degree graduates must demonstrate:

- the skill: (i) to analyse products, processes and complex engineering systems from their study field; (ii) to select and apply relevant methods from the category of analytical, numerical and experimental methods; (iii) to interpret correctly the results of such analyses;
- the skill: (i) to identify, formulate and solve engineering problems specific to their field of study; (ii) to select and apply relevant methods from the category of analytical, numerical and experimental methods; (iii) to recognize the importance of non-technical constraints – societal, economic, industrial, environmental, occupational health and safety.

- **Engineering design:**

The Bachelor's degree graduates have to demonstrate:

- the skill: (i) to develop and design products, processes and complex systems from their field of study, which fulfils certain requirements including the awareness of non-technical considerations – societal, economic, industrial, environmental, occupational health and safety; (ii) to select and apply relevant design methodologies;
- the skill to elaborate projects taking account of close-up elements of engineering specialization they graduated.

- **Research:**

The Bachelor's degree graduates have to demonstrate:

- the skill: (i) to make bibliographical studies, consult and use critically the scientific databases and other relevant information sources, to make simulations and analyses for the detailed follow-up of technical aspects from their field of study;
- the skill to consult and apply codes of good practice and regulations regarding the work safety in their field of study;
- the skill to design and do experimental research in laboratory/workshop, to interpret results and formulate conclusions, in their field of study.

- **Engineering practice:**

The Bachelor's degree graduates have to demonstrate:



- understanding of techniques and methods applicable for analysis, design and research and their limits in the field of study;
- practical skills for the resolution of complex problems, realization of complex engineering projects and performance of research in their field of study;
- understanding the types of materials, equipment, tools, technologies and applicable engineering processes and their limits, in the field of study;
- the skill to apply standards and normative acts specific to engineering practice, in their field of study;
- awareness of non-technical implications – societal, economic, industrial, environmental, occupational health and safety – in engineering practice;
- awareness of economic, organizational and management aspects (such as project management, risk management and change management) in industrial context and business environment.

- **Formation of opinions:**

The Bachelor's degree graduates have to demonstrate:

- the skill to collect and interpret relevant data and to manage the complexity of their study field;
- the skill to manage technical or professional complex activities or projects, in their field of study, with the undertaking of responsibility for the decisions made;

- **Communication and team work:**

The Bachelor's degree graduates have to demonstrate:

- the skill to communicate efficiently information, ideas, problems and solutions, with the engineering community and with society in general;
- the skill to operate efficiently in national and international context, as individuals and team members, and to collaborate efficiently with engineers and non-engineers.

- **Lifelong training:**

The Bachelor's degree graduates have to demonstrate:

- the skill to recognize the need for lifelong training and to independently engage in this process;
 - the skill to pursue the achievements in the field of science and technology.

3.2 Expected outcomes for Master's degree programmes

- **Knowledge and understanding**

The Master's degree graduates have to demonstrate:

- profound knowledge and understanding of notions of mathematics and other sciences on which the engineering specialization they graduated is based, at a sufficient level to develop also the other competences defined as expected results;
- profound knowledge and understanding of engineering subjects at the basis of specialization, at a sufficient level to develop also the other competences defined as expected results;
- critical awareness of close-up elements which define specialization;
- critical awareness of the wider multidisciplinary context, of engineering and knowledge of interface aspects between different fields.

- **Engineering Analysis:**

The Master's degree graduates have to demonstrate:

- the skill: (i) to analyse products, processes and new and complex engineering systems in the wider or multidisciplinary context; (ii) to select and apply relevant methods from the category of analytical, numerical and experimental methods or new and innovative methods; (iii) to interpret correctly the results of such analyses;
- the skill to conceptualize products, processes and engineering systems;
- the skill: (i) to identify, formulate and solve incompletely defined engineering problems/with concurrent specifications/which involve aspects from outside the study field and non-technical constraints – societal, economic, industrial, environmental, occupational health and safety; (ii) to select and apply the most adequate and relevant methods from the category of analytical, numerical and experimental methods or new and innovative methods, for the purpose of solving engineering problems;
- the skill to identify, formulate and solve complex problems in new and emerging fields of specialization graduated.

- **Engineering design:**

The Master's degree graduates have to demonstrate:

- the skill: (i) to develop and design products, processes and new and complex systems, with incomplete or concurrent specifications, which require the integration of knowledge from different fields and non-technical constraints – societal, economic, industrial, commercial, environmental, occupational health and safety; (ii) to select and apply the most adequate and relevant design methodologies or to use own creativity for development of new and original design methodologies;
- the skill to elaborate projects, knowing and understanding the close-up elements of engineering specialization they graduated.

- **Research:**



The Master's degree graduates have to demonstrate:

- the skill to identify, localize and obtain the required data;
- the skill to make bibliographical studies, to consult and critically use the scientific databases and other sources of information, to perform simulations for the detailed follow-up of complex technical aspects;
- the skill to consult and apply codes of good practice and regulations regarding work safety;
- the skill to design and accomplish complex experimental research in laboratory/workshop, to critically interpret the results and formulate conclusions;
- the skill to investigate the application of new and emerging technologies from the close-up of engineering specialization graduated.

• **Engineering Practice:**

The Master's degree graduates have to demonstrate:

- global (comprehensive) understanding of techniques and methods applicable for analysis, design and research and their limits;
- practical skills, including computer use skills, for resolution of complex problems, realization of complex engineering projects, design and performance of complex research;
- global understanding of types of materials, equipment, tools, technologies and applied engineering processes, and their limits;
- the skill to apply standards and specific normative acts of engineering practice;
- knowledge and understanding of non-technical implications – societal, economic, industrial, environmental, occupational health and safety – in engineering practice;
- critical awareness of economic, organizational and management aspects (such as project management, risk management and change management)

• **Formation of opinions:**

The Master's degree graduates have to demonstrate:

- the skill to integrate knowledge and manage complexity, formulate opinions in the conditions of incomplete or limited information, opinions which include the reflection on social and ethical responsibility regarding the application of knowledge and opinions formulated;
- the skill to manage complex technical or professional activities or projects which may require new strategies of approaching, with undertaking of responsibility for the decisions made.

• **Communication and team work:**

The Master's degree graduates have to demonstrate:

- the skill to use various methods for clear and unambiguous communication of conclusions, and knowledge and motivation on which the conclusions are based, to an audience formed by specialists and non-specialists, in national or international context;
- the skill to operate efficiently in national and international context, as members or leaders of a team which can be composed of different disciplinary areas and levels and which could use virtual communication tools.

- **Lifelong training:**

The Master's degree graduates have to demonstrate:

- the skill to engage independently in the lifelong training process;
- to perform an autonomous individual supplementary study.

4. Organization and coordination of study programme

The accredited study programmes which require EUR-ACE® certification are organized and coordinated so as to assure:

- realization of mission and objectives of study programme;
- realization of a teaching and learning process which allows the students to obtain the expected results of the study programme;
- provision of adequate human and material resources;
- monitoring of regulations regarding admission, transfer, route and graduation of students;
- observance of internal quality assurance procedures.

4.1 Mission and objectives of study programme

The mission and objectives of study programme must reflect the requirements of employers and other actors on labour market. The outcomes of study programme must be demonstrated in line with the mission and objectives declared.

The mission and objectives of study programme have to take into account: the employment opportunities of graduates on labour market, the potential developments in the field of technology, the requirements of employers, the wide range of applications in engineering, the opportunities of continuing studies at postgraduate level by graduates, the mission of university and interests of students.

4.2 Teaching-Learning process

The Teaching-Learning process has to allow the graduates of engineering study programmes to prove knowledge and understanding, skills and competences set out in the outcomes of

study programme. The curriculum has to contain information on the method of obtaining these requirements.

The curriculum has to offer comprehensive information about all the subjects including: the subject sheets, the learning outcomes under the form of specific competences accrued, teaching-learning methods, allocation of credits, evaluation methods, pre-conditions or other specific requirements of the study programme. The learning outcomes specified in the subject sheets must be in line with the mission and objectives of the programme. The curriculum has to allow the selection of a flexible route by the student, by the presence of optional and elective subjects.

The learning process has to be sufficiently flexible to allow different levels of training for students and different learning styles. If the curriculum provides practice activities or allows the realization of mobilities in other higher education institutions, the study programme must be evaluated from the prospect of contribution of those elements to the obtaining of programme outcomes.

The evaluation of students must envisage the obtaining of learning results under the form of specific competences accrued, for each subject, and the process should be equally thorough and correct. Whenever it is possible, we recommend grading the works or moderation of evaluation by a second teaching staff member. The students have to have the opportunity to take the outstanding examinations, provided that it is achieved without compromising the quality standards.

There is and is applied an external independent control regarding the evaluation of students and decisions regarding their learning route and finalization; the process assures the fulfilment of quality standards regarding the outcomes of the study programme. The organization of this process must be documented.

4.3 Resources

The resources allotted to the study programme must be enough to allow the students to demonstrate the knowledge and understanding, the competences and skills set out in the outcomes of study programme.

The teaching staff has to exist in enough number and have the adequate training and experience for the subjects taught. There should be training programmes which allow the technical staff, the technical and administrative staff to update their knowledge regarding the use of new technologies.

The laboratories, the computer rooms and workshops have to be equipped with necessary equipment for the study programme. The organization of activities in these facilities has to assure on one hand the safe access of students and on the other hand, the possibility to carry out the practical activities, especially those which contribute to the realization of projects.



The support services for students, which include but are not limited to tutorship, library and other resources of information and documentation, support for identification of practice places, must be easily accessible to students.

There should be an adequate budget for the carrying out of study programme.

4.4 Admission, transfer, route of students and finalization of studies

The conditions for admission, transfer and route of students, respectively for finalization of studies, must be specified and made public and the outcomes of these processes must be monitored.

The students must be informed about the admission conditions and the regulations regarding their learning route in view of studies finalization. The transfer conditions in terminal year must be clearly specified.

The registers which record the results of students provide essential information for the revision and development of programmes. There should be regulations and they should be applied for monitoring the route of students, the data collected and analysed should be used for the revision and development of study programme; in particular, we should also record the number of dropouts and the reasons which led to school dropout. We should monitor the general performance of students in various subjects from curriculum, in order to identify the evaluation outcomes which are significantly different from the usual ones.

4.5 Internal Quality Assurance

The study programmes certified EUR-ACE® have to be supported by policies and effective quality assurance procedures.

The programme has to have quality assurance procedures which are in line with the quality assurance policy of the higher education institution which organizes it. There should be a defined and documented procedure for the revision of programme at regular intervals, using all the relevant data, including an evaluation of results of students compared to the declared objectives of the study programme.

There should be an established format for the collection of feedback from the students, for all the subjects from the curriculum, which allows the efficient evaluation of all these subjects. There should be a working method regarding the administration of study programme which allows the resolution of any emergency problems in due course.

The information on all the aspects of the study programme, including the quality assurance procedures, should be available to the public.

Note: This document was approved by the ARACIS Council in the meeting of 31 August 2016.

ARACIS Council