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Subject-Specific Criteria of the Technical Committee 13 – Physics

For the accreditation of Bachelor's and Master's degree programmes in physics and related degree programmes orientated on physics

(adopted: 20 March 2020)

The following specifications complement the "ASIIN General Criteria for the Accreditation of Degree Programmes".

1 Classification

1.1 Function

The Subject-Specific Criteria (SSC) of the Technical Committee for Physics have the premise that the intended learning outcomes, formulated by Higher Education Institutions in their own responsibility and in accordance with their academic profile, form the central yardstick for the curricular evaluation of the study programmes submitted for accreditation.

In addition, the Subject-Specific Criteria of all ASIIN Technical Committees fulfil a number of important functions:

The SSC are the result of a regular assessment carried out by ASIIN Technical Committees, which summaries what is understood as best practice in higher education in a professional community supported equally by academia and professional practice and what is demanded as future-oriented training quality in the labour market. The expectations outlined in the SSC for the achievement of learning outcomes and competency profiles are not static. Rather, they are subject to constant examination in close cooperation with organisations of the specialist community, including associations of faculties and university departments, professional associations and federations of the professional practice. For this purpose, the Technical Committee for Physics cooperates with the *Konferenz der Fachbereiche Physik (KFP;* conference of the Physics Departments of German Universities) and the *German Physical Society (Deutsche Physikalische Gesellschaft, DPG)* (see below). Applicant universities are requested, with the help of the SSC, to critically reflect on the interaction of the learning outcomes, curricula and related quality expectations they themselves strive for and to position themselves in the light of their own university objectives.

In their function in the accreditation procedure, the SSC also represent a professionally elaborated basis for discussion for experts, universities and committees of ASIIN. They thus make an important contribution to the comparability of national and international accreditation procedures, since it should not be left to the opinion of individual experts which technical parameters flow into the discussion and the individual evaluation. At the same time, the SSC name those abilities, skills and competences which may typically be considered “state of the art” in a subject area, but which can always be exceeded or varied depending on the objectives of a higher education institution

For inter- and multidisciplinary degree programmes, the SSC provide indications for their presentation and evaluation. However, the SSC are basically oriented towards the respective core subjects of the individual disciplines.

The SSC are positioned and coordinated internationally and contribute to the realisation of the European Higher Education Area. They act on demands of the European "Bologna 2020" strategy to formulate subject-specific, discipline-oriented learning outcomes as one of the most important instruments for the promotion of academic and professional mobility in Europe as a quality requirement. The SSC take into accountr, among other things, the diverse preparatory work within the framework of European projects (e.g. "Tuning") and specialist networks.

1.2 Scope of the ASIIN Subject-Specific Criteria and Consistency with Further Subject-Specific Criteria

These Subject-Specific Criteria update the ASIIN Subject-Specific Criteria in the version of 29.03.2019 and the recommendation about the conception/ design of study programmes in physics at the bachelor’s and master’s level, published by the Konferenz der Fachbereiche Physik (KFP) on 08.11.2010. In cooperation with the German Physical Society, the Subject-Specific Criteria for Physics are continually reviewed, whether they are up-to-date, and if necessary revised. Furthermore, the Subject-Specific Criteria comply with the goals and quality standards set by the *Mathematics-Natural Sciences Faculty Committee* (MNFT, association of all German faculties and departments for natural sciences and mathematics). On 22.12.2015, the MNFT joined the *Strategic Partnership to Safeguard and Develop High Quality Standards in Academic Education for MINT (Strategische Partnerschaft zur Sicherung und Weiterentwicklung hoher Qualitätsstandards in der akademischen MINT-Bildung)*, which was founded by ASIIN and the *4ING - Faculty Committee of Engineering and Informatics at Universities* (association of faculties and departments for Engineering and Informatics at German Universities) together with the *Conference of Subject Area Committees* (KFBT, association of all faculties and departments of German Universities of Applied Sciences). The central objective of this strategic partnership is to establish and intensify the long-standing cooperation in the further development of professional requirements for the development and quality assurance of study programmes in the technical and natural sciences that meet the demands of science and professional practice equally well on a binding basis.

1.3 Collaboration of the Technical Committees

The Technical Committee Physics works together with the other Technical Committees of ASIIN, mostly to give consideration to the requirements of interdisciplinary study programmes. The universities are called upon to submit their assessment of the assignment of one or several Technical Committees in the course of the application for an accreditation procedure.

The field of responsibility of the Technical Committee comprises two focal points – on the one hand the principally research-oriented university degree programmes “Physics” and on the other hand the degree programmes “Physical Technology”, mostly offered by universities of applied sciences, which are, as a rule, application-oriented. It is not possible to define general rules for additional degree programmes, where it needs to be decided individually on the basis of which educational elements the objective of the studies can be reached best.

Based on sound knowledge of the fundamentals of mathematics and physics, the degree programme “Physical Technology” provides application-oriented knowledge including modern physical developments. The respective Subject-specific Criteria were developed by the Technical Committee 5 (Physical Technologies, Materials and Processes). They are updated in collaboration with the Technical Committee 13 with a special focus on the assurance of a comprehensive and well-founded education in the fundamentals of physics.

As to degree programmes that are particularly close to the degree programme “Physics”, the Subject-specific Criteria issued by the Technical Committee 13 also serve as a basis for external quality assessment in the accreditation procedure.

2 Educational Objectives and Learning Outcomes

The educational objectives are outlined by the description of the learning outcomes required by the graduates for practising their profession or for post-graduate studies. The outcomes vary in extent and intensity in accordance with the differing objectives of Bachelor’s and Master’s programmes.

2.1 Requirements for Bachelor’s Degree Programmes

Successfully completed Bachelor’s degree programmes are to facilitate early professional careers (professional qualification) as well as qualify the graduates for advanced scientific degree programmes or additional postgraduate education in a subject other than physics. With their knowledge and skills graduates of Bachelor’s degree programmes in physics have a qualification based on sound fundamentals of natural sciences and mathematics, certain key qualifications, and a high degree of flexibility which, in particular, provides an excellent basis for further qualification and specialisation. They are able to discuss and classify socially relevant physical topics on a scientific basis (preparing them for social commitment). They are principally qualified to complete corresponding Master’s degree programmes. This means in detail that:

- They have sound knowledge of classical physics (mechanics, electrodynamics, thermodynamics, oscillations, waves and optics) and are familiar with the fundamentals of quantum, atomic and molecular, nuclear, elementary particle and solid state physics.

- They are familiar with important mathematical methods used in physics and can use these to solve physics problems.

- They have an extensive understanding of the fundamental principles of physics, their inherent relation and mathematical formulation and, based on this, have acquired methods suitable for theoretical analysis, modelling and simulation of relevant processes.

- They have applied their knowledge to physics problems in an exemplary manner and studied some areas in greater depth, thereby acquiring a first basis for problem solving competence.

- They have a basic capacity to comprehend physics problems. This will in general however not yet facilitate a deeper understanding of current research areas.

- They are therefore in a position to independently classify physics-based and to some extent also interdisciplinary problems that require a target-oriented and logic-based approach, and to analyse and/or solve them by using natural scientific and mathematical methods.

- They are familiar with basic principles of experimentation, are able to use modern physics measurement methods, and are in a position to assess the significance of results correctly.

- They have generally also acquired an overview knowledge in selected other natural science subjects or technical disciplines.

- They are able to apply their knowledge to different fields and act responsibly in their professional activity. They are moreover able to recognise new trends in their subject area and integrate the relevant methodology – if necessary after appropriate qualification – into their further work.

- They are able to continuously and independently extend and deepen the knowledge acquired in the Bachelor's degree programme. They are familiar with suitable learning strategies (lifelong learning) for this; they are in particular qualified for a consecutive Master's degree programme in principle.

- They have gained initial experience with regard to generic qualifications (e.g. time management, study and work techniques, willingness to cooperate, capacity for teamwork, communication and presentation skills,, communication and presentation techniques,programming skills) in their degree programme, and are able to develop these skills further.

- They are familiar with the basic elements of the relevant specialised English.

- They are able to solve a simple scientific problem and to present their results orally (talk/presentation) and in writing (demonstrated in a Bachelor’s thesis).

- They know the rules of good scientific practice.

2.2 Requirements for Master’s Degree Programmes

As a continuation of a first university degree, Master’s degree programmes lead to the development and extension of the analytical-technical competences acquired in first-cycle degree programmes. At the same time, the technical competences gained in undergraduate studies are advanced and extended. The knowledge and skills acquired by graduates of Master’s degree programmes in physics cover the comprehensive professional profiles of physicists highly regarded

for its technical broadness and flexibility; they are principally qualified to pursue doctoral studies. This means in detail that:

- They have advanced their knowledge in natural sciences and mathematics, extended their overview of connections within physics as well as to neighboring disciplines, and have specialised in one field of physics in such a way that they can find access to current international research.

- They have applied their knowledge to examples of complex physical problems and tasks to analyse, formulate, and solve them as comprehensively as possible on a scientific basis.

- They are qualified to plan, construct, and conduct experiments and interpret the results (focus on experimental physics) or use modelling and simulation on the basis of physical fundamental principles (focus on theoretical physics) in order to solve complex physical problems.

- They have acquired generic competences in their degree programme, e.g. in the areas communication, presentation, project work and capacity for teamwork.

- They can edit and present scientific topics according to different audiences' needs.

- They have advanced knowledge of relevant specialized technical English. Basic knowledge of another foreign language is desirable.

- They have gained the capacity to acquaint themselves with any special area in physics/technology, to research and understand the relevant current international specialist literature, to conceive and conduct experiments or theoretical methods in the field, to classify the findings in the light of diverse physical phenomena, and to draw conclusions for technical developments and scientific progress.

- They have gained the necessary persistence to cope with failures, unexpected difficulties and delays in research and development projects and still reach the target using a modified strategy if necessary.

- They are in a position to commence professional activity even in a field not related to the area of specialisation of the Master's degree programme, using their basic knowledge of physics together with the scientific methods and problem-solving strategies acquired.

- They are qualified to discuss complex physical issues and their own research findings within the context of current international research comprehensively and to present them in written (Master's Thesis) and oral form (presentation with free discussion).

- They understand fundamental aspects of scientific theory formation and are able to correctly assess the scope of approximations and models.

- They are aware of their responsibility towards science and possible consequences of their activities for the environment and society and act in accordance with the „Guidelines for Safeguarding Good Research Practice" (Deutsche Forschungsgemeinschaft).

3 Curriculum

The educational objectives of a degree programme in physics are achieved as students gain a diversity of knowledge, skills and competences through various didactic methods in the course of the degree programme. The extent to which students reach the intended learning objectives during the degree programme is determined by course and examination assessments. This should be expressed through the form of examination selected as well as the content of the examination.[1] The curriculum should contain options for the students to choose and thus offer students the opportunity to sharpen their individual profiles. The programme offers the opportunity for students to gain an insight into professional fields and to recognize the relevant key qualifications.

[1] Exemplary didactic concepts and assessment methods for different groups of learning outcomes can be found at: http://www.kfp-physik.de/dokument/KFP_Handreichung_Konzeption-Studiengaenge-Physik-101108.pdf