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HIGHER EDUCATION WITH A SPECIALISATION IN LIGHT ENGINEERING AND LIGHT SOURCES AND TRANSFER TO FSES3^{++}

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ABSTRACT

The article describes the problems associated with previous Federal State Education Standards (FSES) in the Electronics and Nanoelectronics education speciality and education plans of the Light Engineering and Light Sources Bachelor's programme as well as education plans of the Theoretical and Applied Light Engineering Master's programme. Due to the adoption of FSES3^{++} and approval of professional educational standards, the light engineering community was offered to take part in the discussion of the issues of new education plans elaboration.

Keywords: FSES of higher education, the federal state educational standard of higher education, FSES of higher professional education, the federal state educational standard of higher professional education

The bachelors and masters in the area of light engineering are trained by NRU MEI, Kazan State Power Engineering University, N.P. Ogarev National State Research University of Mordovia (Saransk), Don State Technical University (Rostov-on-Don) and Saint-Petersburg State University of Film and Television.

The Light Engineering department of MPEI was established in 1933, it was the first such department established in the USSR.

In accordance with the orders of the Ministry of Education and Science of the Russian Federation [1, 2] under the common name of FSES3^{++}, the higher education institutions shall transfer to the education of students in accordance with these documents beginning from September 1, 2019.

Before discussing today's problems, let us remember the past. There were two specialities in the Light Engineering department of MPEI at the end of the 20th century: 1) Light Engineering and Light Sources; 2) Optoelectronic Devices and Systems. The selection of one of the three possible programmes (Electronics and Microelectronics, Electrical Engineering and Optical Engineering) within the scope of the second speciality was accompanied by serious discussions, and the first programme was selected for several reasons. The main one is related to the development of science and equipment and, therefore, many disciplines of the sub-division in the field of electronics. This mainly includes semi-conductor (LED) emitters, light control systems, control gears for discharge lamps, and LED control equipment a little later. Nowadays it is already difficult to imagine such disciplines of the sub-division as Light Devices, Designing and Technology of Manufacturing of Light Devices, Light Design Technologies, and Contemporary Problems of Electronics without LED light sources. The new programmes in these fields will appear and the existing ones will be developed by the new education plan. In the meantime, the second speciality was quite easily transformed into Quantum and Optical Electronics.

During the period from 2000 to 2010, the Ministry of Education of the Russian Federation also conducted education in accordance with the diplomat programme 645100 Electronics and Microelectronics, which included special disciplines, in particular, for the speciality 180600 Light Engineering and Light Sources alongside with the federal and national-regional (institution)-level disciplines. The names of the disciplines (the Basics of Light Engineering, Photometry, Lighting Installations, Lighting Devices, etc.), as well as brief content of these disciplines, were clearly formalised. These disciplines determined the training of the industry specialists and complied with the speciality.

The education plans of the students of MPEI comprised the specialists and bachelors plans of the 550700 Electronics and Microelectronics programme (the best students graduated from the master's technical and technological programme with this profile too). Both these standards of higher professional education also comprised not only the names of the disciplines, but brief content of the same [3, 4].

Since 2010, the plans have begun to change dramatically. The order of the Ministry of Education and Science [3, 4] does not contain the disciplines and specialities of the 210100 Electronics and Nanoelectronics programme any longer, and contains common and professional competences instead of them, as well as the major professional educational programme (MPEP defined by an institution in accordance with the approximate major educational programme of higher professional education) with standard terms of education and workload in credits (1 credit is equal to 36 academic hours). The area of professional activity of bachelors (masters) is described including "theoretical and experimental research, mathematical and computer modelling, designing, production technology, application and usage of materials, components of electronic instruments, devices, vacuum, plasma, solid-state, microwave, optical, micro and nanoelectronic installations with various functional use"… The types of professional activity were introduced: design activities, production and technological activities, science and research activities, management activities, erection and commissioning activities, service and operational activities.

Since this moment, a graduate should have common and professional competences, and this trend has been increasing although achievement of the required indicators (knowledge, skills, hereinafter referred to as the indicators) are defined by MPEP of a specific institution. Since this moment, the competence approach has become governing.

It is expressly noted that higher education institutions should update the major educational programmes every year with consideration of the development of science, engineering, culture, economy, technologies, and social sphere. This Federal State Education Standard (FSES), as well as FSES [5, 6], noted that MPEP should contain disciplines selected by the students with the scope of at least one-third of the variable part. The procedure of formation of student-selected disciplines was set by the academic board of an institution.

The list of minimal inventory required for the implementation of, for instance, a Bachelor's programme was also defined and included measurement, diagnostic, technological facilities, equipment, and installations, as well as computers united in local networks with the Internet access provided with the licensed software packages for solving tasks in the field of electronics and nanoelectronics.

The Masters' laboratory courses should be equipped with a sufficient number of experimental sets for performing laboratory works by all students of the relevant profile. The number of students using one experimental set simultaneously should not exceed two.

Naturally, based on this FSES, the institutions should get the money required for purchase of such inventory, at least theoretically, so these clauses were just removed from the subsequent versions. Only broad terms were left: "the organisation shall possess educational inventory (premises and equipment) on the right of ownership or on another legal basis." [1, 2]

The 2012 May Orders of the President of Russia kicked off formation of the state policy for the development of the National System of Qualifications and formed the basis of the system of ***professional standards*** as an alternative for the existing system of documents regulating the labour market. On December 9, 2013, the President of Russia V. Putin noted: "The professional standards should become a real reference point for the educational system, a mandatory one – I want to underline it – in the course of development of educational programmes of our universities, lyceums, and colleges." The President of Russia ordered the Government of Russia to take the provisions of pro-

fessional standards in the course of formalisation of FSES of higher education, after which the process of FSES updating based on the professional standards was organised.

The structure of FSES3++ [1, 2] is significantly different from the previous FSES3+ [5, 6], the FSES itself has a framework nature with an enhancement of the status of approximate major educational programmes (AMEP). The goal of the application of FSES of higher education and AMEP is the unification of the educational area and achievement of the contemporary level of training.

The major MPEP of higher education is still developed and approved by an educational institution (NRU MPEI in our case) based on the requirements of FSES of higher education and with consideration of AMEP. AMEP is a set of educational and methodological documents developed with the consideration of the requirements of the regional labour market, the requirements of federal executive authorities and industry requirements regulating the goals, the expected results, the content, forms, conditions and technologies of educational process organisation, evaluation of the graduate training quality.

The evaluation of the graduate training quality is conducted based on achievement in training the **competences**: universal common competences of FSES and professional competences based on professional standards (UC, CC, and PC respectively). In case of non-availability of professional standards, PCs are formalised on the basis of the requirements analysis to professional activity imposed by the labour market as well as generalisation of domestic and foreign experience, international standards with consideration of industry development trends. The set of competences should provide a graduate's readiness to act in the selected area of professional activity and limited sphere of professional activity.

In the course of MPEP development, it is necessary to take opinions of the parties (employers, enrolees, students, lecturers) interested in education on the basis of this MPEP into account, to define the areas of professional activity of graduates, to select the types of professional activity objectives, and to define the list of major objects (or knowledge areas).

Therefore, the main attention should be paid to cooperation between the institutions (NRU MPEI in our case) and employer.

Despite the fact that the students were trained in the Electronics and Nanoelectronics speciality in the Light Engineering department of MPEI, the high qualification specialists, i.e. Candidates and Doctors, defended and keep defending their theses in the State Commission for Academic Degrees and Titles speciality 05.09.07 Light Engineering [7] contained in the group of specialities 05.09.00 Electric Engineering.

In 2017, the Light & Engineering / Svetotekhnika Journal organised a discussion regarding the description of the speciality and the following generalisation was formulated: "Light Engineering is an area of science and engineering developing the methods of generation, spatial redistribution of optical radiation as well as its transformation into other types of energy and application for various purposes," which significantly broadened the previous variant ("The science speciality uniting theoretical and experimental studies for modernisation of existing and development of brand new sources of artificial light and irradiation"). Within the scope of the speciality, the methods of design of light (illuminating) devices, lighting installations, and photometric monitoring systems are developed, the processes in the volumes of discharge and incandescence light sources, elements of light sources, materials, and light source operation mode control systems are studied. The studies are made for the purpose of development of high-efficient, environment-friendly light sources providing the required aesthetic perception of object, comfort, significant reduction of power consumption, economical efficiency of operation.

Based on the comparison of these formulations, it is already seen that it is proposed to broaden the research areas and, therefore, the specialist training areas.

Due to non-availability of the regulated disciplines in FSES of higher education, the educational institutions, NRU MPEI in this case, have a number of questions again: is light engineering closer to the Electric Engineering or Electronics and Nanoelectronics speciality from employers' point of view? Which competencies (knowledge, skills) do graduates lack?

Naturally, each institution has its permanent employers but it should be clearly understood that technical education is impossible without financial and informational support: both technical equipment of educational and science laboratories with

contemporary instruments and clear formulations related to required skills of graduates are required.

Recently, the Ministry of Labour and Social Protection has introduced the professional standards: for specialists in light design and design of innovative lighting installations and for specialists in the development of LED-based lighting devices. However, the professional activity of, for example, the former professional standard is very broad: it includes manufacturing of electric lamps and lighting equipment, development of architectural concepts and development of projects relating not only to electric engineering and electronic equipment but also to mining engineering, chemical technology, visual design, etc.!

In our opinion, it is simply impossible to train a specialist with such a broad area of activities neither in 4 nor in 6 years. The more so because the generalised labour functions listed in this professional standard are much narrower and closer to conventional training of specialists.

The graduate bachelors should design lighting objects and lighting installations and the graduate masters should create lighting objects and installations concepts.

Naturally, the marketing issues should be addressed too.

A light solution designer shall perform the duties that are incompatible with each other at first sight: to be an engineer and an artist at the same time, to develop both the lighting concept and the power supply scheme, to select equipment and to supervise correctness of its installation. However, the lighting engineering department has a large experience in such education. As early as in 1995, professor A.B. Matveev and associate professor V.I. Petrov established a unique speciality Lighting Architecture, Styling, and Advertising. It was established thanks to large experience and talent of Alexander B Matveev who, at the same time with the education in MPEI, graduated from the Moscow Art Theatre School and was not only a Doctor of Technical Sciences but also a good artist as well as a designer of more than 25 performance of the Soviet Army Theatre and many performances of other theatres. As a result, the founders of the speciality and their followers have been successfully training young people in technical skills and elements of artistic perception within the scope of the Bachelor's programme and selected Master's programme disciplines of our university as well as in the postgraduate course Lighting Equipment and Design for more than 20 years.

During the 2018/2019 academic year, the Light Engineering department, as well as the whole faculty, has been keeping preparing new education plans compliant with the FSES3++. The applicable bachelors training education plan adopted in 2016 contained the following common disciplines: Nanoelectronics, Circuit Engineering, Basics of the Electronic Component Base, Materials of Electronic Engineering, Theoretical Basics of Light Engineering, Vacuum and Plasma Electronics, Quantum and Optical Electronics and Solid-State Electronics. We think that the mentioned common disciplines should be kept and that employers and the light engineering community may provide us with significant assistance. We are waiting for proposals with the sections of working programmes or specific themes required by contemporary specialists especially for ones working in the areas mentioned in this article.

The future disciplines of the new bachelors training education plan are being actively discussed by the lecturers of the department, but we think that the light engineering disciplines will include the conventional ones such as Basics of Light Engineering, Computer Graphics, Lighting Devices, Lighting Installations, Introduction to Light Design, Sources of Optical Radiation, Control Gears, and the new ones, e.g. Designing and Manufacturing Technology of LED-based Lighting Devices, Lighting Control Systems, and Light-Emitting Diodes.

The discussion of the disciplines of the new bachelors training education plan has just begun and the Light Engineering department of NRU MPEI is open for suggestions. We would also like to note that the existing plan already comprises the lighting design disciplines such as Technologies of Lighting Design, Computer Graphics in Light Engineering, Lighting Equipment and Design, Modelling and Evaluation of Light and Colour Environment, Daylighting and Artificial Lighting; as well as the areas based on the LED light sources and lighting devices based on them, e.g. Technologies of Development of Light Sources and Control Gears, Equipment and Methods of Lighting, Design of Optical Systems of Light Devices.

Editorial note

We offer all concerned persons to express their suggestions regarding modernisation of the educational system in our journal, to take a direct part in the enhancement of inventory of the Lighting Engineering department for the purpose of quality increase of both graduate trainings and advanced courses for employees of different organisations.

REFERENCES

1. The Order of the Ministry of Education and Science of the Russian Federation No. 927 dated on September 19, 2017 "On Approval of the Federal State Education Standard of Higher Education for Bachelor's Programme with Profile 11.03.04 Electronics and Nanoelectronics."

2. The Order of the Ministry of Education and Science of the Russian Federation No. 959 dated on September 22, 2017 "On Approval of the Federal State Education Standard of Higher Education for Master's Programme with Profile 11.04.04 Electronics and Nanoelectronics."

3. The Order of the Ministry of Education and Science of the Russian Federation No. 743 dated on December 21, 2009 "On Approval of the Federal State Education Standard of Higher Professional Education in specialty Electronics and Nanoelectronics (the bachelor's degree)."

4. The Order of the Ministry of Education and Science of the Russian Federation No. 31 dated on January 14, 2010 "On Approval of the Federal State Education Standard of Higher Professional Education in specialty Electronics and Nanoelectronics (the master's degree)."

5. The Order of the Ministry of Education and Science of the Russian Federation No. 218 dated on March 12, 2015 "On Approval of the Federal State Education Standard of Higher Education for Bachelor's Programme with Profile 11.03.04 Electronics and Nanoelectronics."

6. The Order of the Ministry of Education and Science of the Russian Federation No. 1407 dated on October 30, 2014 "On Approval of the Federal State Education Standard of Higher Education for Master's Programme with Profile 11.03.04 Electronics and Nanoelectronics."

7. URL: https://teacode.com/online/vak/p05–09–07.html.

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