



STUDIJŲ KOKYBĖS VERTINIMO CENTRAS

VILNIAUS UNIVERSITETO
STUDIJŲ PROGRAMOS *Optoelektronikos medžiagos ir technologijos*
(valstybinis kodas – 621J50002)
VERTINIMO IŠVADOS

EVALUATION REPORT
OF *Materials and Technology of Optoelectronics*
(state code - 621J50002)
STUDY PROGRAMME
at VILNIUS UNIVERSITY

Experts' team:

1. Prof. dr. Laurens Katgerman (team leader) *academic,*
2. Prof. dr. Janis Spigulis, *academic,*
3. Prof. dr. Andres Öpik, *academic,*
4. Dr. Denis Guilhot, *academic,*
5. Dr. Sergejus Orlovas, *representative of social partners'*
6. Ms Milena Medinickienė, *students' representative.*

Evaluation coordinator –

Ms Rasa Paurytė

Išvados parengtos anglų kalba

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DUOMENYS APIE ĮVERTINTĄ PROGRAMĄ

Studijų programos pavadinimas	<i>Optoelektronikos medžiagos ir technologijos</i>
Valstybinis kodas	621J50002
Studijų sritis	Technologijos mokslai
Studijų kryptis	Medžiagų technologijos
Studijų programos rūšis	Universitetinės studijos
Studijų pakopa	Antra
Studijų forma (trukmė metais)	Nuolatinės (2)
Studijų programos apimtis kreditais	120
Suteikiamas laipsnis ir (ar) profesinė kvalifikacija	Medžiagų technologijų Magistras
Studijų programos įregistravimo data	2007-03-28

INFORMATION ON EVALUATED STUDY PROGRAMME

Title of the study programme	<i>Materials and Technology of Optoelectronics</i>
State code	621J50002
Study area	Technological Sciences
Study field	Materials Technologies
Type of the study programme	University Studies
Study cycle	Second
Study mode (length in years)	Full-time (2)
Volume of the study programme in credits	120
Degree and (or) professional qualifications awarded	Master of Materials Technology
Date of registration of the study programme	28-03-2007

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 The Centre for Quality Assessment in Higher Education

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I. INTRODUCTION

1.1. Background of the evaluation process

The evaluation of on-going study programmes is based on the **Methodology for evaluation of Higher Education study programmes**, approved by Order No 1-01-162 of 20 December 2010 of the Director of the Centre for Quality Assessment in Higher Education (hereafter – SKVC).

The evaluation is intended to help higher education institutions to constantly improve their study programmes and to inform the public about the quality of studies.

The evaluation process consists of the main following stages: 1) *self-evaluation and self-evaluation report prepared by Higher Education Institution (hereafter – HEI)*; 2) *visit of the review team at the higher education institution*; 3) *production of the evaluation report by the review team and its publication*; 4) *follow-up activities*.

On the basis of external evaluation report of the study programme SKVC takes a decision to accredit study programme either for 6 years or for 3 years. If the programme evaluation is negative such a programme is not accredited.

The programme is **accredited for 6 years** if all evaluation areas are evaluated as “very good” (4 points) or “good” (3 points).

The programme is **accredited for 3 years** if none of the areas was evaluated as “unsatisfactory” (1 point) and at least one evaluation area was evaluated as “satisfactory” (2 points).

The programme **is not accredited** if at least one of evaluation areas was evaluated as "unsatisfactory" (1 point).

1.2. General

The Application documentation submitted by the HEI follows the outline recommended by the SKVC. Along with the self-evaluation report and annexes, the following additional documents have been provided by the HEI before, during and/or after the site-visit:

No.	Name of the document
1.	Table on admitted and graduated students 2013/2015 and 2014/2016.
2.	List of 7 recently defended Master Thesis.

1.3. Background of the HEI/Faculty/Study field/ Additional information

Vilnius University (founded in 1579) is the oldest university in the Baltic States and one of the oldest in Northern Europe. Currently it has approximately 14.3 thousand first cycle students, 3.4 thousand

second cycle students, more than 800 PhD students and more than 800 resident physicians; 243 professors, 453 associated professors and 523 researchers are employed. Vilnius University has 12 faculties, 7 institutes, 4 research and study centres.

Study programme *Materials and Technology of Optoelectronics* is carried out at the Faculty of Physics under supervision of Semiconductor Physics Department. The research related to the programme curriculum is mainly carried out at this department and at the Institute of Applied Research. The programme was registered on March 28th, 2007, and external comprehensive assessment of the programme for the registration purpose was carried out the same year; the assessors did not observe any essential drawbacks.

1.4. The Review Team

The review team was completed according *Description of experts' recruitment*, approved by order No. 1-01-151 of Acting Director of the Centre for Quality Assessment in Higher Education. The Review Visit to HEI was conducted by the team on 26/05/2016.

1. **Prof. dr. Laurens Katgerman (team leader)** *Delft University of Technology, Professor Emeritus, The Netherlands.*
2. **Prof. dr. Janis Spigulis**, *University of Latvia, Professor of Physics Department, Head of Biophotonics Laboratory at Institute of Atomic Physics and Spectroscopy, Latvia.*
3. **Prof. dr. Andres Öpik**, *Tallinn University of Technology, Vice Dean of the Faculty of Chemical and Materials Technology, professor of physical chemistry, Estonia.*
4. **Dr. Denis Guilhot**, *The Institute of Photonic Sciences, Knowledge and Technology Transfer Programme Manager, Spain.*
5. **Dr. Sergejus Orlovas**, *Centre for Physical Sciences and Technology, Principal Research Fellow, Lithuania.*
6. **Dr. Milena Medinickienė**, *doctoral student of KTH Royal Institute of Technology (Lithuania, Sweden).*

II. PROGRAMME ANALYSIS

2.1. Programme aims and learning outcomes

As stated in the self-evaluation report (SER, p.5), the aims of this study programme are:

1. Training of highly qualified, international standards meeting experts

- ✓ able to master the most promising technologies of organic and inorganic semiconductors for light sources, solar cells, hybrid technologies;
 - ✓ knowing and able to participate in solving newest scientific and technological problems in field of optoelectronics;
 - ✓ able to work independently, organize work of others and to take responsibility for the results and research/project management.
2. Generate and use innovative ideas for their work in the field of science, industry, economy in order to increase competitive ability of Lithuania industry.
 3. Training of highly qualified material technology specialists for post graduate studies in physics, chemistry, materials science and similar study fields.

The aims and learning outcomes were established according to the Dublin Descriptors, to Decision No. 535 of May 4, 2010 of the Government of the Republic of Lithuania “On Approval of the Description of Lithuanian Qualifications Structure”, and to Decree No. V-2212 of November 21, 2011 of the Minister of Education and Science of the Republic of Lithuania “On Approval of the Description of Study Cycles”. The aims and learning outcomes are publicly accessible - available online: <http://www.vu.lt/studijos/apie-studijas/studiju-programos>; <http://www.vu.lt/en/studies/study-programmes>. They are clearly defined at Table 2 of SER.

The programme goals are in line with the National Strategic Plan of Social and Economic Development of Lithuania stating that new university study programmes are to be created, improved and implemented for biotechnology (e.g., biochemistry, microbiology, genetics, bioinformatics), laser technologies (e.g., laser physics, optical mechanics, laser electronics, *optical technologies*), information technologies (telecommunications) and other strategic scientific research sectors, including integrated, interdisciplinary study programmes. Adoption of high technologies in business requires highly skilled professionals; in many emerging areas, including optoelectronics, master level education is requested. The programme aims and learning outcomes are based on high academic and professional standards; they meet public needs for new high-tech products and also the labour market needs for professionals in the high-tech development and production. Progress in these sectors will create new jobs and help to solve the unemployment-associated social problems.

The offered qualification level after graduation is Master in Materials technology. The programme aims and learning outcomes generally are consistent with the type and level of studies. Eventually, a more appropriate qualification of graduates could be Master in Applied Physics; it was generally agreed in on-site meetings that this option should be further considered as the knowledge on technological applications acquired is substantial and not only focussed at materials.

The name of the programme, its learning outcomes, content and the qualifications offered are compatible with each other. The graduates demonstrate ability to contribute in the related research field (confirmed by high-level student's publications, Table 16a of SER) and to work in optoelectronics business enterprises (SER, Table 17). On the other hand, more practice in real business environment of optoelectronics enterprise(s) seems to be necessary for a Master in *technology* if international standards are supposed to be met (SER, p.5).

2.2. Curriculum design

The study programme meets the requirements for the second-cycle higher education study programmes and is in compliance with the "Description of General Requirements for Master Studies" approved by Decree No. V-826 of June 3, 2010 of the Minister of Science and Education of the Republic of Lithuania and Decree No. V-231 of February 8, 2012 of the Minister of Science and Education of the Republic of Lithuania "On Replacement of Approval of Description of General Requirements for Master Studies", "Regulation of VU Study Programs", approved by the Commission of VU Senate on 2012-06-21 (decision SK-2012-12-4) and changes to it (up to 2013-10-24 decision Nr. SK-2013-12-14). The content of the programme and the sequence of the course units ensure that the students gradually acquire basic knowledge, experimental skills and analytic, synthetic and assessment skills in two main directions (SER, p.7):

- 1) electrical and optical properties of materials, physical basics of electronic and optoelectronic devices, modern electronic and optoelectronic devices,
- 2) semiconductor materials and their nanostructures, technologies of material production and processing, new materials and technologies.

Choice of the optional subjects allows focusing more deeply on

- 1) silicon photovoltaics, or
- 2) photonics and adaptive optics.

According to SER (p.10), 448 study hours are allocated to lectures and, depending on the selected course units, 104-112 hours are allocated to laboratory works (directly associated with the lecture courses), 200-208 hours to seminars and 21 credits for scientific research; individual studies take the majority of study time - 1085 hours or 59%.

On-site discussions of Review Team (RT) with programme developers revealed that the tasks for individual studies could be better specified and regular monitoring of student's performance can be recommended. Eventually, number of credits awarded for individual studies in some cases could be

reduced and one or more new lecture course introduced, e.g. “Optical Design” (as suggested by social partners at the on-site meeting).

Equal number (30) of credits has to be earned each semester, which makes 120 credits in total. Table 3 of SER lists all programme courses and their distribution over semesters. Study subjects are spread evenly, their themes are not repetitive – see Table 4 at SER. The course units are consistent with the type and level of studies. According to Table 3 of SER, the following courses (number of credits in brackets) are taught:

1st semester - Methods of advanced microscopy (6), New Materials and Technologies (7), Technologies of Organic Optoelectronics (6), Modern semiconductor devices – physics and technology (6), Perception of light and colour (5);

2nd semester - Energy-Saving Semiconductor Technologies (4), Nanostructures and Material Engineering (5), Physics and technology of inorganic optoelectronics devices (8), Physics and technology of disordered materials (5);

3rd semester - Solid-State Lighting Technology (8), Management of Technology (4), optional course - Photonics and adaptive optics (5) or Production Technologies of Silicon Solar Cells (5).

In addition, Scientific Research Work (8) is carried out at the 2nd semester, Scientific Research Practice (13) at the 3rd semester and MA final thesis (30) are elaborated at the 4th semester.

The praxis at research institutions is taken by most students of the programme; however, praxis at industrial optoelectronics-oriented enterprises should be more encouraged to get better technology- and production-related skills of the graduates.

Content of the subjects is certainly appropriate to achieve the expected outcomes. Seven subjects are specific for this particular programme, while five are common for Master students of this and two other faculty programmes - “Crystal Silicon Photovoltaic Solar Cells Technologies”, “Physics and Technologies of Disordered Materials”, “Advanced Materials and Technologies”, “Technologies of Organic Optoelectronics”, “Energy-Saving Semiconductor Technologies” (SER, p.9.).

The learning outcomes are both academic- and business-oriented; the latter requires lots of practical skills. Table 3 of SER shows that laboratory works comprise 80 hours (10%) in the 1st semester, 24 hours (3 %) in the 2nd semester and, depending of the selected free-choise course, 24 or 16 hours (3% or 2%) in the 3rd semester. Undoubtedly, practical skills are acquired also during the scientific research work/practice hours (210 and 345, respectively); however, more practice in real business environment of optoelectronics enterprise(s) seems to be necessary to ensure all declared learning outcomes, if international standards for a Master in *technology* are supposed to be met (SER, p.5).

The set of specialized courses provides good insight in the latest technological achievements of optoelectronics (examples, Table 3: New Materials and Technologies, Technologies of Organic Optoelectronics, Modern semiconductor devices – physics and technology, Energy-Saving Semiconductor Technologies, Nanostructures and Material Engineering, Physics and technology of inorganic optoelectronics devices, Physics and technology of disordered materials; Solid-State Lighting Technology). Independent preparation for seminars involve own presentation and discussions on presentations of other students. In this process students get acquainted with the latest research literature and develop critical approach to solution of problems. Undoubtedly, most of the Master Thesis projects (including those elaborated in research institutes) are directly related to solving of current problems in optoelectronics technologies.

2.3. Teaching staff

According to SER (p.12), teaching staff for the programme is selected by open tender procedure for 5-year period. All candidates must conform to requirements set by the law for educators of certain categories. The performance criteria are: teaching and total work experience, fields of research interests, the number of published research papers related to the subject(s) being taught, students' feedback on the lecturer and the quality of studied courses. So, the general legal requirements are met.

The presented CVs confirm adequate qualification of the teaching staff. The teaching staff is composed of 9 professors, 3 associated professors and 2 research scientists (Table 5 of SER); ten of them represent Vilnius University and four - Centre for Physical Sciences and Technology. All of the teachers hold a doctoral degree. Scientific qualification of the teaching staff in terms of Hirsch index (h) is very impressive: for eleven teachers it is in the range 10-23 and for three in the range 5-8; 62.5 % of teachers are professors and 44% hold professor's pedagogical title (SER, Table 5). Most of them have high-ranked publications on their teaching subjects; the only exception appears to be "Management of Technology" where no publications on management topics could be presented in SER (the only "related" publication in Table 5 is on conjugated polymers and fullerenes, a specific research topic).

The total number of teachers (14) seems to be adequate for ensuring the claimed teaching outcomes, with respect to the number of students enrolled. All employed teachers also supervise the students' research work, Master Theses or course papers. The average number of contact hours per teacher in this programme is between 52 and 59; the mean workload might increase to 67 h due to the expected age-related transfer of the teaching duties (SER, p.16).

The average age of the teachers is almost 56; according to SER (p.16), it may remain stable in the near future, as several teachers are approaching the mandatory retirement age and will soon be replaced by younger researchers. The average age of teachers who are expected to continue teaching for the next 5 years is around 53 years.

International contacts and teachers' work in research and methodological projects are directly related to their professional development. SER points out as weakness (p.17) that not adequate attention is paid to the development of the teachers' methodological skills. The majority of teachers actively perform research work, but do not spend enough time on methodological improvement. Teachers participate in international workshops and visits in institutions abroad but no institutional sabbatical leave program is offered, reducing the opportunities for long stays. Increased teachers' internationality can be suggested (i.e. lecturing abroad, sabbatical leaves).

The research component of this programme is very strong. The programme-associated research is mainly reflected in the titles of Master Thesis, supervised by internationally recognized experts in the field (Annex 4 of SER), and by the high proportion of graduates pursuing their studies through a PhD. All teachers of the study programme present reports at scientific conferences in Lithuania and abroad. As stated in p.16 of SER, the teachers also take part in various international projects as well as in projects of the Research Council of Lithuania and the Agency for Science, Innovation and Technology. 13 teachers have participated in various collaborative research projects since 2010. Methodological projects are also carried out, e.g. the currently developed TEMPUS Programme project *Development of Training Network for Improving Education in Energy Efficiency* (SER, p.15). Participation at such projects raises teachers' methodological qualification level. 4 teachers have taken part in various internships in foreign research and study institutions over the last 5 years.

2.4. Facilities and learning resources

According to SER (p.17), most of the lectures, seminars and workshops of the programme take place in the Faculty of Physics room 704 (54 m², 30 seating capacity) of the Semiconductor Physics Department. Laboratory works are held in three teaching laboratories and nine scientific laboratories in the Semiconductor Physics Department, Institute of Applied Research and Semiconductor Physics Institute of CPST (SER, Table 8a – 3 teaching laboratories, Table 8b – 11 research laboratories). The on-site visited laboratories for student's experiments are equipped with up-to-date instrumentation, some of which is recently purchased and installed in the VU campus new building with excellent working conditions; *wi-fi* is available everywhere.

Laboratory and computer equipment is fully up-to-date and accessible to all students. Through the support of EU Structural Funds projects, ~175 000 EUR (600 000 Lt) were spent to renovate laboratory equipment of the Faculty of Physics. In addition, yearly allocation EUR 2000-3000 is

provided for materials needed for the completion of laboratory works and for small-scale renovation (SER, p.20). Renovation results are summarized in Table 9 of SER.

The EU support projects enabled to acquire modern experimental equipment and renovated laboratory rooms; some examples of the newly acquired equipment (SER, p.19):

- Metal organic chemical vapour deposition reactor (VU Institute of Applied Research);
- Molecular Beam Epitaxy device (CPST SPI);
- Microscopic spectrometry measurement complex, atomic force microscope and confocal microscope (VU SPD).

This completed the existing laboratory equipment used for student's training (SER, p.20), including:

- complex for measurement of luminescence and Raman scattering (Luminescence Laboratory),
- setup exploiting the light-induced transient grating technique (Optical Diagnostics Laboratory),
- luminescence spectrometer with picoseconds time resolution (Optoelectronics Laboratory),
- equipment for investigation of light-emitting diodes (Solid-State Lighting Laboratory),
- microwave device for study of carrier photoconductivity kinetics and spectral distribution,
- equipment for study of spectral distribution and temperature characteristics of photoconductivity,
- spectrometer for study of deep-level centers in semiconductors,
- device based on photo-Hall effect and magnetoresistance,
- electronic paramagnetic resonance spectrometer,
- equipment for study of thermostimulated currents and polarisation (Photoelectric Phenomena Laboratory).

As an innovation, four laboratory works were made remote recently - these works can be performed via Internet. It is important for disabled students and those who cannot come to the laboratory at the appointed time, e.g. due to illness; also students of other universities may have access, if registered. However, all computer network security requirements are not met so far and a special software has to be purchased/installed to launch the "remote laboratories" (SER, p.18).

Scientific practice of students usually take place in the Semiconductor Physics Department, Institute of Applied Research and CPST - Centre for Physical Sciences and Technology. These institutions have adequate arrangements for students' practice and also financial resources for part-time salaries, so they traditionally attract most of the programme students (SER, p.21).

With financial support for research, practice outside research institutions becomes less attractive. SER (p.21) states that business companies that receive students for practice are burdened with undesired bureaucracy even if they are completely satisfied with their knowledge and abilities. However, during the meeting with social partners they expressed readiness to provide praxis placements for a limited number of students (e.g. 1-2 per year). RT would recommend to improve communication of faculty with industrial partners (e.g. “Vilniaus Ventos puslaidininkiai”, “Ekspla”, “Šviesos Konversija”, “Ageta”, “Optoelektronikos sprendimai”, “The Applied Research Institute for Prospective Technologies (ProTech)”, “Brolis Semiconductors”, etc - p.22 of SER) so ensuring more opportunities for students to get acquainted with real business environment and its specifics.

VU library subscribes a number of international databases related to the programme courses. The library operates at modern facilities of the National Open Access Scholarly Communication and Information Centre (SCIC) <http://www.mkic.mb.vu.lt/en/>, located next to Faculty of Physics. The Centre has more than 670 working places, many of them computerized with Internet access; the major international databases are available. Students can also use university computer classroom of common use, which is located in VU Centre of Information Technology Development, and also other computer classrooms of the Faculty. The students can also connect to the subscribed databases from their homes by using the University supplied VPN (*Virtual Private Network*) service (SER, p.22).

With support of Structural Funds, 11 new textbooks for the study programme (in Lithuanian) were published in 2008 (SER, p. 19). Structural fund projects, e.g. "Optoelectronics technologies expansion for science and studies (OPTOSTUD)", helped to purchase scientific books and textbooks amounting to LTL 118 000; the major part of this literature is suitable for the students of the programme (SER, p.22). The teachers of the department have uploaded visual aids and synopses as well as laboratory work descriptions of most of the study courses' lectures on the website of the Semiconductor Physics Department <http://pfk.ff.vu.lt>.

Generally, the resources for the programme implementation are good, and there is an optimistic future vision. In the *Saulėtekis Slėnis (Sunrise Valley)* project, large investments are provided for the development of the optoelectronics technologies, giving new opportunities for students not only to characterize materials and devices, but also to produce on their own new materials, structures and device prototypes (SER, p.23).

2.5. Study process and students' performance assessment

Graduates of the first cycle physical and technological university studies holding the Bachelor degree are admitted to the second cycle *Materials and Technology of Optoelectronics* study programme.

Bachelor graduates of other areas are admitted only if they attend the required introductory courses of the study programme and present thesis on a topic from physical or technological research area. Persons are admitted to the second cycle studies by competition. Applicants are rated according to their competition scores. Information for the competition score is taken from the diploma and its supplement. The competition score is formed from the results in General physics, Calculus, Quantum mechanics, Statistical physics, entrance examination, additional scores for research production, and assessment for Bachelor thesis (SER, p.23).

Programme admission data are presented on Table 12 of SER. Over five years (2010-2014), the number of admitted students has varied in-between 7 and 10, with a tendency to grow. The total number of submitted applications has been considerably higher, 25 to 39. Most of the students are VU physics bachelors, only two were enrolled from “outside” – KUT (SER, p.23).

Organization of study process follows the main guidelines for studies in Vilnius University. The theoretical background provided during lectures is consolidated during practical classes. Laboratory experiments provide information about experimental research techniques and develop the skills needed for work in research laboratories and manufacturing facilities. The workshops (solution of problems) and seminars train student’s abilities to determine logical relationships between various phenomena and to draw appropriate conclusions, as well as the skills to defend own opinion. Table 14 of SER indicates the ratio of time spent for lectures, workshops and self-study (including time for research work). Self-study work of this programme takes 55-61 % of all the time of students’ work and, as turned out during the on-site discussions, could be better defined and monitored.

Another potential improvement of the study process could be introduction of a universal online study information platform, e.g. MOODLE. This could be done only in collaboration with the central departments of Vilnius University.

All programme students are involved in research. 21 credits are allocated for scientific research (8 credits in the second semester and 13 credits in the third semester), passing over all stages of research: literature analysis, formulation of research objectives, selection of research methods and tools, collection of results, primary processing, assessment of reliability, analysis and synthesis of results, assessment of scientific value and novelty; formulation of conclusions and work presentation. The task is completed by a scientific research summary having the structure of a research paper (SER, p.10). Tables 16 and 16a (SER, p.27) provide data on Master student’s scientific publications, typically around 10 per year (or ~1 per student). The research practice can take place in scientific institutes and/or industrial companies with applied research facilities (SER, p.10). On-site meeting confirmed that most of the programme students intend to continue their research after graduation as PhD students.

Table 15 of SER provides data about the number of programme students who participate in mobility programmes, typically 2+/-1 per year. The number of vacancies allotted for the Physics Faculty to participate in the *Erasmus* programme is lower than the demand (SER, p.25) due to a low number of students coming from abroad. On the other hand, the low number of *Erasmus* or other foreign MA students does not facilitate lecturing in English and makes difficult to publicly offer studies in this programme for foreign students, even when the most of lecturers would be able to switch Lithuanian language to English (SER, p.17). RT recommends solving this issue ASAP in collaboration with the authorities of Vilnius University.

Vilnius University ensures all the relevant support to this study programme (more details at the VU website). The general grading system at VU (including this programme) is clear, adequate and publicly available at the website. In some cases, the criteria for grading are not well enough defined. As example, RT found that the recent grades for final thesis are only 10 or 9, while one could expect some more even dispersion. Also the number of credits awarded for the research work and research project (2nd, 3rd semester) could be better justified. At the on-site meeting it was acknowledged that faculty understands and will avoid the risks of double-crediting, related to those two subjects and the final thesis.

Employment data of the programme graduates are provided in Table 17 of SER (p.28). More than 50% of the graduates successfully continue their education in the doctoral studies (32% in Vilnius University, 9.6% in CPST and the other 13 % in foreign universities); about 20 % of the graduates find employment in Lithuanian business companies. None of the programme graduates is officially unemployed. Such statistics generally meets the expectations of the programme providers.

2.6. Programme management

The programme management structure is clearly defined in SER (p.28). The Study Programme Committee (SPC) of the programme is composed of the teachers from the Faculty of Physics, the students recommended by Students' Representation Office and the representatives of the social partners. The head of SPC is elected from the Committee members by the simple majority of votes. The Study Programme Committee offers amendments to the programme and to admission, submits them for approval to the Council of the Faculty, discusses and confirms the course units' descriptions approved at the meetings of the departments. The heads of the departments are in charge of the course units' quality and the study process of these course units. The course of the study programme is administered by the Dean and the Vice-dean for academic issues. The questions of the programme administration are discussed weekly at the meetings of the heads of departments. The faculty has Students' Representation Office, students' self-government representatives are members of the

Council of the Faculty of Physics, the Study Programme Committee, the Appeals Board, the Labour Dispute Board, the Teaching and Research Performance Evaluation Committee. The Dean's office gets information on problems of the programme from the students' self-governance representatives.

The annually renewed plan of the study programme is published on Vilnius University information system which generates timetables of examinations, sends messages to students (about the deadlines of registering for optional and free course units, etc.) and teachers (the date and place of examination, etc.). Student can find out what his or her study plan is, check the assessments and register for optional courses and free courses; the study plan is not changed until student completes the studies (SER, p.29).

As stated during the on-site interviews and was also mentioned in SER (p.31), the study programme committee is not active enough. It only meets up to twice a year and has not introduced any visible programme improvements recently. RT would recommend organizing more frequent meetings (e.g. once in 1-2 months) with participation of programme students and industry representatives to discuss in details the programme implementation and improvement issues.

The programme implementation is monitored by means of the students' feedback (SER, p.29). Since the spring semester of 2008-2009, students are surveyed online after each semester, when all exams are taken. Surveys about the studied course are organized by VU Quality Management Centre and participation in the survey is mandatory. All teachers can find information about the students' feedback of his/her course in the "Surveys" field. The survey results are accessible for the Study Programme Committee, student's feedback on the courses taught by the department teachers is available to the head of the corresponding department. The data on students' satisfaction with the study programme are presented in Annex A, and student's feedback results are summarized in Table 18 of SER. The total evaluation average of the programme is higher than average at Vilnius University, with considerable deviations in student's responses. As stated in SER (p.30), individual communications with 5-12 students of this programme concerning the study quality is probably more productive than the statistical analysis of the answers to pre-planned questions.

As acknowledged during the on-site meeting, some improvements of the programme have been implemented as response to student's feedback and the internal/external evaluations; however, data on such improvements are not public and students do not see how their feedback is taken into account.

Representatives of stakeholders are involved in examination commissions of Master thesis and in the study programme committee. There is certainly still space for further involvements of industrial partners.

The VU internal quality assessment system based on student's feedback collection and analysis, as described in SER, seems to be working. Problems concerning academic honesty of students were identified, so now the student's papers are verified by the plagiarism control software of VU.

2.7. Examples of excellence *

Excellent research base and very prominent scientists as lecturers of the programme courses.

III. RECOMMENDATIONS

1. **Consider revision of percentage of individual study hours for the programme courses, with clear monitoring system of the time and results of individual learning.**
2. **Avoid the risks of double-crediting in the research subjects.**
3. **Find ways to attract foreign students to the programme.**
4. **Find ways to ensure more practical skills of students, obtained in optoelectronics companies.**
5. **Consider eventually better adjusted to the programme's content name of the awarded qualification, e.g. Master in Applied Physics (or similar).**

IV. SUMMARY

To summarize, the main findings related to each assessed area are briefly presented below.

Programme aims and learning outcomes are clearly defined and consistent with the type and level of studies; the offered qualification level after graduation is Master in Materials Technology. The graduates demonstrate ability to contribute in the related research field and to work in optoelectronics business enterprises. However, more practice during the studies in real business environment of optoelectronics enterprise(s) seems to be necessary for a Master in *technology* if international standards are supposed to be met. Eventually, a more appropriate qualification of graduates could be Master in Applied Physics, Master in Optoelectronics or similar; update of the offered qualification is recommended as the knowledge on technological applications is not focussed at materials only.

Curriculum design is in line with the defined programme aims; content of the subjects is certainly appropriate to achieve the expected outcomes. The curriculum comprises lectures, laboratory works, seminars and research work; individual studies take the majority of study time (1085 hours or 59%). The tasks for individual studies could be better specified and regular monitoring of student's

performance can be recommended. Eventually, number of credits awarded for individual studies could be reduced and one or more new lecture course introduced, e.g. “Optical Design”. The praxis at research institutions is taken by most students of the programme, but very few students acquire practical skills at optoelectronics-oriented companies.

Teaching staff is highly qualified, composed of 9 professors, 3 associated professors and 2 research scientists. All of the teachers hold a doctoral degree. Scientific qualification of the teaching staff in terms of Hirsch index (h) is very impressive: for eleven teachers it is in the range 10-23 and for three in the range 5-8; 62.5 % of teachers are professors and 44% hold professor’s pedagogical title. The majority of teachers actively perform research work, but do not spend enough time on methodological improvement. Increased teachers’ internationality can be suggested (i.e. lecturing abroad, sabbatical leaves).

Facilities and learning resources are excellent. Special attention is paid to student’s laboratories and research infrastructures. Through the support of EU Structural Funds projects, laboratory rooms and equipment were recently renovated. The laboratories for student’s experiments are equipped with up-to-date instrumentation, purchased and installed in the VU campus new building. Information related to the programme courses is available in library that operates at modern facilities located next to Faculty of Physics. Students can use university computer classroom of common use or computer classrooms of the Faculty, or connect to the subscribed databases from their homes by using VPN. 11 new textbooks for the study programme (in Lithuanian) were published in 2008.

Study process and students’ performance assessment is appropriate. Organization of study process follows the main guidelines for studies in Vilnius University. Special attention is paid to development of research skills, which results in Master student’s scientific publications, typically around 10 per year (or ~1 per student). Most of the programme students intend to continue their research after graduation as PhD students. Self-study work of this programme takes most of the study time and could be better defined and monitored. Another potential improvement of the study process could be introduction of a universal online study information platform, e.g. MOODLE. The criteria for grading are not always well enough defined - as example, the recent grades for final thesis are only 10 or 9, while one could expect some more even dispersion. The number of credits awarded for the research work and research project (2nd, 3rd semester) could be better justified. The risks of double-crediting, related to those two subjects and the final thesis, should be avoided.

Programme management structure with Study Programme Committee (SPC) as the core element is clearly defined. However, SPC meets only up to twice a year and has not introduced any visible programme improvements recently, so it is recommended to organize more frequent meetings (e.g.

once in 1-2 months) with participation of programme students and industry representatives. The programme implementation is monitored by means of the students' feedback. Some improvements of the programme have been implemented as response to student's feedback and the internal/external evaluations; however, data on such improvements are not public and students do not see how their feedback is taken into account.

Positive quality aspects:

- High level research and the related facilities
- Good collaboration with partners

To be improved:

- International exchanges and dimension, sabbaticals
- Grading system (thesis 9/10; individual studies monitoring/assessment)
- Course management in MOODLE or similar
- Title of the awarded degree
- More focus to optoelectronic devices and optical design (needed for industry)

V. GENERAL ASSESSMENT

The study programme Materials and Technology of Optoelectronics (state code – 621J50002) at Vilnius University is given **positive** evaluation.

Study programme assessment in points by evaluation areas.

No.	Evaluation Area	Evaluation of an area in points*
1.	Programme aims and learning outcomes	3
2.	Curriculum design	3
3.	Teaching staff	4
4.	Facilities and learning resources	4
5.	Study process and students' performance assessment	3
6.	Programme management	3
	Total:	20

*1 (unsatisfactory) - there are essential shortcomings that must be eliminated;

2 (satisfactory) - meets the established minimum requirements, needs improvement;

3 (good) - the field develops systematically, has distinctive features;

4 (very good) - the field is exceptionally good.

Grupės vadovas: Team leader:	Prof. Dr. Laurens Katgerman
Grupės nariai: Team members:	Prof. dr. Andres Öpik
	Prof. Dr. Janis Spigulis
	Dr. Denis Guilhot
	Dr. Sergejus Orlovas
	Dr. Milena Medinickienė

**VILNIAUS UNIVERSITETO ANTROSIOS PAKOPOS STUDIJŲ PROGRAMOS
OPTOELEKTRONIKOS MEDŽIAGOS IR TECHNOLOGIJOS (VALSTYBINIS KODAS –
621J50002) 2016-08-19 EKSPERTINIO VERTINIMO IŠVADŲ NR. SV4-190 IŠRAŠAS**

<...>

V. APIBENDRINAMASIS ĮVERTINIMAS

Vilniaus universiteto studijų programa *Optoelektronikos medžiagos ir technologijos* (valstybinis kodas – 621J50002) vertinama **teigiamai**.

Eil. Nr.	Vertinimo sritis	Srities įvertinimas, balais*
1.	Programos tikslai ir numatomi studijų rezultatai	3
2.	Programos sandara	3
3.	Personalas	4
4.	Materialieji ištekliai	4
5.	Studijų eiga ir jos vertinimas	3
6.	Programos vadyba	3
	Iš viso:	20

* 1 - Nepatenkinamai (yra esminių trūkumų, kuriuos būtina pašalinti)

2 - Patenkinamai (tenkina minimalius reikalavimus, reikia tobulinti)

3 - Gerai (sistemiškai plėtojama sritis, turi savitų bruožų)

4 - Labai gerai (sritis yra išskirtinė)

<...>

2.7. Išskirtinės kokybės pavyzdžiai (geroji praktika)*

Aukštos kokybės tyrimų bazė ir garsūs mokslininkai, dėstantys studijų programos dalykus.

<...>

IV. SANTRAUKA

Apibendrinant, toliau pateikiamos pagrindinės išvados, susijusios su kiekviena vertinama sritimi.

Programos tikslai ir studijų rezultatai aiškiai apibrėžti ir atitinka studijų tipą ir lygmenį; baigus studijas suteikiama Medžiagų technologijų magistro kvalifikacija. Absolventai geba prisidėti prie susijusios tyrimų srities ir dirbti optoelektronikos verslo įmonėse. Vis dėlto, technologijų magistro kvalifikacija reikalauja daugiau praktikos studijų metu realioje optoelektronikos verslo įmonės aplinkoje, siekiant atitikti tarptautinius standartus. Galiausiai, tinkamesnis studijų programą baigusių studentų kvalifikacijos pavadinimas būtų Taikomosios fizikos magistras, Optoelektronikos

magistras ar pan.; rekomenduojama atnaujinti kvalifikacijos pavadinimą, nes technologijų taikymo žinios nėra orientuotos vien tik į medžiagas.

Programos sandara atitinka nustatytus programos tikslus; dalykų turinys neabejotinai tinkamas numatytiems studijų rezultatams pasiekti. Studijų turinys apima paskaitas, laboratorinius darbus, seminarus ir tiriamąjį darbą; didžiąją studijų laiko dalį užima savarankiškas darbas (1 085 val., arba 59 %). Savarankiško darbo užduotys galėtų būti geriau apibrėžtos, taip pat rekomenduojama reguliari studentų veiklos rezultatų kontrolė. Galiausiai, savarankiškam darbui skirtų kreditų skaičius galėtų būti sumažintas, o į studijų programą galėtų būti įtrauktas vienas ar daugiau naujų dalykų, pvz., Optinis dizainas. Dauguma studijų programos studentų atlieka praktiką tyrimų institucijose, tačiau labai mažai jų įgyja praktinių įgūdžių optoelektronikos srityje.

Dėstytojų kvalifikacija aukšta; personalą sudaro 9 profesoriai, 3 docentai ir 2 mokslininkai. Visi dėstytojai turi daktaro laipsnį. Mokslinė dėstytojų kvalifikacija, vertinant pagal Hiršo indeksą (h), išpūdinga: vienuolikos dėstytojų h yra 10–23, o trijų – 5–8; 62,5 % dėstytojų yra profesoriai, o 44 % – docentai. Didžioji dalis dėstytojų aktyviai vykdo tyrimus, tačiau nedaug laiko skiria metodikai tobulinti. Siūloma gerinti dėstytojų tarptautiškumą (t. y. paskaitų skaitymą užsienyje, mokslininko kūrybines atostogas).

Materialieji ištekliai yra puikios kokybės. Specialus dėmesys skiriamas studentų laboratorijoms ir tyrimų infrastruktūrai. Gavus paramą iš ES struktūrinių fondų lėšomis finansuojamų projektų, neseniai atnaujinti laboratorijų kabinetai ir įranga. Studentų eksperimentų laboratorijos aprūpintos naujausiais prietaisais, įsigytais ir sumontuotais naujajame VU pastate. Informacija, susijusi su studijų programos dalykais, prieinama bibliotekoje, veikiančioje modernioje bazėje netoli Fizikos fakulteto. Studentai gali naudotis universiteto bendro naudojimo kompiuterių klase arba Fakulteto kompiuterių klasėmis; taip pat yra galimybė prisijungti prie prenumeruojamų duomenų bazių iš savo namų naudojant virtualųjį privatų tinklą (VPN). 2008 m. išleista 11 naujų vadovėlių (lietuvių k.), skirtų šiai studijų programai.

Studijų eiga ir jos vertinimas yra tinkami. Studijų eiga organizuojama vadovaujantis pagrindinėmis Vilniaus universiteto studijų gairėmis. Ypatingas dėmesys skiriamas tyrimų įgūdžiams ugdyti. To rezultatas – magistrantūros studentų mokslinės publikacijos, kurių paprastai per metus pasirodo apie 10 (arba maždaug po 1 publikaciją studentui). Dauguma programos studentų baigę studijas ketina tęsti tyrimus doktorantūroje. Savarankiškas darbas užima didžiąją studijų programos dalį, todėl jį reikėtų geriau apibrėžti ir kontroliuoti. Studijų eigą taip pat būtų galima pagerinti įdiegiant universalią nuotolinių studijų informacijos platformą, pvz., MOODLE. Vertinimo pažymiais kriterijai taip pat ne visada pakankamai gerai apibrėžti. Pavyzdžiui, paskutiniai baigiamieji darbai įvertinti tik dviem pažymiais: 10 arba 9, tačiau tikimasi tolygesnio pažymių pasiskirstymo. Už tiriamąjį darbą ir tiriamąjį projektą (2, 3 semestrai) suteikiamų kreditų skaičius galėtų būti geriau

pagrįstas. Reikėtų vengti dvigubo kreditų skyrimo, susijusio su pirmiau nurodytais dviem dalykais ir baigiamuoju darbu.

Programos vadybos struktūra, kurios pagrindinis elementas yra Studijų programos komitetas (SPK), yra aiškiai apibręžta. Vis dėlto, SPK posėdžiai rengiami tik iki dviejų kartų per metus ir jokių akivaizdžių programos pagerinimų pastaruoju metu nebuvo pasiūlyta, todėl rekomenduojama dažniau rengti posėdžius (pvz., kartą per vieną ar du mėnesius), kuriuose dalyvautų studijų programos studentai ir pramonės atstovai. Programos įgyvendinimo stebėseną vykdoma pasitelkiant studentų grįžtamąjį ryšį. Kai kurie programos pagerinimai buvo įgyvendinti, atsižvelgiant į studentų grįžtamąjį ryšį ir vidinį bei išorinį vertinimus; tačiau duomenys apie tokius pagerinimus nėra viešinami ir studentai nemato, ar į jų komentarus atsižvelgiama.

Teigiami kokybės aspektai:

- Aukšto lygio tyrimai ir susijusi materialioji bazė
- Geras bendradarbiavimas su partneriais

Tobulintini aspektai:

- Tarptautiniai mainai ir apimtis, mokslininko kūrybinės atostogos
- Vertinimo pažymiais sistema (baigiamųjų darbų vertinimas: 9 arba 10; savarankiško darbo kontrolė / vertinimas)
- Studijų dalykų valdymas MOODLE ar panašioje sistemoje
- Suteikiamo laipsnio pavadinimas
- Daugiau dėmesio optoelektronikos prietaisams ir optiniam dizainui (reikalinga pramonei)

<...>

III. REKOMENDACIJOS

Peržiūrėti studijų programos dalykų savarankiško darbo valandų skaičių ir nustatyti aiškią savarankiško darbo laiko ir rezultatų kontrolės sistemą.

Vengti dvigubo kreditų skyrimo tiriamiesiems dalykams.

Rasti būdų, kaip pritraukti užsienio studentus į studijų programą.

Rasti būdų, kaip užtikrinti, kad studentai įgytų daugiau praktinių įgūdžių optoelektronikos įmonėse.

Apsvarstyti labiau prie programos turinio pritaikytą suteikiamos kvalifikacijos pavadinimą, pvz., Taikomosios fizikos magistras (ar pan.).

<...>

Paslaugos teikėjas patvirtina, jog yra susipažinęs su Lietuvos Respublikos baudžiamojo kodekso 235 straipsnio, numatančio atsakomybę už melagingą ar žinomai neteisingai atliktą vertimą, reikalavimais.

Vertėjos rekvizitai (vardas, pavardė, parašas)