Accreditation Report

Lviv Polytechnic National University

Cluster Computer Science

IP-0624-1

21st Meeting of the ZEvA Commission, 9th of July, 2024

Item 04.02

Study Programme	Degree	Programme Duration	Type of Programme	Maximum annual intake
Information Control Systems and Technologies	Master	3 semesters	Full-time.	75
System Design	Master	3 semesters	Full-time	75
Artificial Intelligence	Master	3 semesters	Full-time	75
Computer Control Systems for Moving Objects (Automobile Transport)	Master	3 semesters	Full-Time	75

Accreditation contract signed on: December 12th 2021

Date of virtual site visit: February 26th/27th 2024

Contact Person at the higher education institution:
Prof. Dr. Anna Helesh, Head's Assistant of the Center for Quality Assurance in Education

ZEvA programme officer: Dr. Barbara Haferkorn

Expert Panel:

- Prof. Dr. Anett Mehler-Bicher, Hochschule Mainz, Business Informatics, Systems Engineering, Vice President
- Prof. Dr. Christoph Rappl, Technische Hochschule Deggendorf, Feedback Control Systems, Information Technology
- Prof Dr. Julian Reichwald, Mannheim University of Applied Sciences, Head of Virtual Engineering Competence Center, Dean, Professor for Business Informatics (Digital Business Technologies)
- Dr. Ievgen Ryzhenko (Didactic Manager at Festo Ukraine); representative for the profession
- Patrizia Jaroscinsky-Bartzel, Technical Univerisity Chemnitz (student expert)

Hanover, 24.06.2024

Table of Contents

I. Final Vote of the Expert Panel and Decision of the Accreditation Commission

1. Decision of the ZEvA Accreditation Commission (9th of July, 2024)

The ZEvA Commission follows the experts' report and recommendations.

The ZEvA Commission decides to accredit the following Master's programmes offered by Lviv Polytechnic National University without conditions for a period of six years:

- *Information Control Systems and Technologies*
- *System Design*
- *Artificial Intelligence*
- *Computer Control Systems for Moving Objects (Automobile Transport)*

This decision is based on the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), the Framework of Qualifications of the European Higher Education Area and the recommendations of the ECTS Users' Guide as referred to in the ZEvA Manual for the External Assessment of Study Programmes.

2. Central Findings and Final Vote of the Expert Panel

2.1 Central Findings of the Expert Panel

The experts have come to the overall conclusion that the university has created current study programmes which provide a variety of career prospects for graduates. The structure and content of the study programmes are well considered and convincing. The graduates receive a sound academic education, research skills and the soft skills needed to succeed in a complex internationalised labour market.

The expert panel is impressed by the teaching faculty and the students they met during the online interviews as well as by the fruitful cooperation with the companies involved in the study programmes.

In addition, the experts have gained a positive overall impression of the educational infrastructure provided for the students. The students benefit from an excellent support system and learning environment, transparent information, the university's network of external partners in the region and beyond and a wide range of possibilities for internationalisation.

The university has developed a sophisticated internal quality assurance system. All internal and external stakeholders, including the students and representatives of companies, are actively involved in the development and continuous improvement of the study programmes.

The experts conclude that the study programmes are in full compliance with the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).

2.2 Final Vote of the Expert Panel

2.3 General Aspects

None.

2.4 Programme 1: Information Control Systems and Technologies

2.4.1 Recommendations

None.

2.4.2 Conditions

None.

2.4.3 Recommendation to the ZEvA Commission:

The expert group recommends the accreditation of the Master's programme "Information Control-Systems and Technologies" for the duration of six years without conditions.

2.5 Programme 2: System Design

2.5.1 Recommendations

None.

2.5.2 Conditions

None.

Recommendation to the ZEvA Commission:

The expert group recommends the accreditation of the Master's programme "System Design" for the duration of six years without conditions.

2.6 Programme 3: Artificial Intelligence

2.6.1 Recommendations

None.

2.6.2 Conditions

None.

2.6.3 Recommendation to the ZEvA Commission:

The expert group recommends the accreditation of the Master's programme "Artificial Intelligence" for the duration of six years without conditions.

2.7 Programme 4: Computer Control Systems for Moving Objects (Automobile Transport)

2.7.1 Recommendation

- Since the topic PLC is rather relevant in production but not in moving objects as such, the experts recommend making this module optional and suggest including a course in Kalman Filtering instead.

2.7.2 Conditions

None.

2.7.3 Recommendation to the ZEvA Commission:

The expert group recommends the accreditation of the Master's programme "Computer Control systems for Moving Objects (Automobile Transport)" for the duration of six years without conditions.

II. Evaluation Report of the Expert Panel

1. Introduction: Purpose, Design and Context of the Accreditation Procedure

It is the purpose of this accreditation procedure to assess the quality of four master's programmes in the field of Computer Science offered by the Lviv Polytechnic National University (LPNU).

The assessment is based on the "Assessment Framework for the Evaluation of Study Programmes" as laid down in the "ZEvA Manual for the Evaluation and Certification of Study Programmes".

This framework integrates the requirements of the "European Standards and Guidelines for Quality Assurance in Higher Education (ESG)" (ENQA 2015), the "Framework for Qualifications for the European Higher Education Area" (2005) and the "ECTS User's Guide" (European Commission, 2015).

As stipulated in the ESG, the assessment was organized as a multiple-step peer review procedure. ZEvA assembled an expert panel composed of three university professors in the discipline, one professional from outside academia and one student.

For the purpose of assessing the study programmes, the university generated a self-report including an appendix of supplementary documents (course syllabi, CVs of teaching faculty, relevant statistical data, rules and regulations). The self-report and all documents were submitted in English.

Upon reception of the self-report, one of the experts (Dr. Ievgen Ryzhenko) travelled to Lviv for a site visit to see the facilities at LPNU (February 2nd 2024). The outcomes of this visit were made transparent to the other experts and were duly accounted for in the assessment process. Following that, the experts conducted a two-day online site visit which included separate interviews with members of the university leadership board, the heads of the departments, academic supervisors and programme coordinators, teaching faculty, students, graduates and employers. The online talks took place on February 26th and 27th 2024.

This report is based on the experts' assessment of the self-report, the on-site visit of one of the experts and the results of the online talks. It will serve as a basis for the ZEvA Accreditation Commission to decide on the accreditation of the study programmes with the ZEvA quality seal. The experts would like to thank all involved members of LPNU faculty and staff for the professional organisation of the online site visit and the open atmosphere during the talks.

2. General Aspects

2.1 Organizational Structure and Mission of the University

The Lviv National Polytechnic University (LNPU) has its origins in the Lviv Gymnasium (founded in 1816), which later became the Lviv Technical Academy (1844). Since then, the university has developed into a renowned centre of science and education, recognised in Ukraine and beyond, and one of the largest universities in the country, with more than 2,000 scientific and teaching staff, including more than 480 professors and 1,300 associate professors. According to its own data, LPNU is now one of the top five universities in Ukraine.

The university comprises 17 educational research institutes, the Institute of Distance Education, the International Institute of Education, 10 colleges, 101 departments, a research department, a doctoral and postgraduate department, and the Tech StartUp School. In addition, the first SID City Science Park in the Lviv region was established at LPNU.

More than 34,000 students are currently enrolled in 67 bachelor's and 181 master's programmes in engineering, natural sciences, economics and social sciences.

LPNU's mission and strategic goals can be summarised as follows (self-report, part 1, p. 2):

"In particular, the mission[1] of the university is reflected in the formation of future leaders who work wisely, creatively, effectively;

Vision - to become the best university in Ukraine in term of international and national rankings.

The values of the university include professionalism, patriotism, integrity, academic freedom, desire for change, spirituality, traditions."

Experts' Appraisal

From the experts' point of view, the institutional profile and mission of LPNU are clearly defined. The central quality goals of the university have been described in sufficient detail in the self-report, on the website and in the university's normative documents and regulations.

Apart from a focus on the employability of graduates, on internalisation and on co-operative relationships with business and industry, the connection between research and the students' education plays an important part in the university's vision of quality and their mission to provide high quality education. The experts appraise the strong focus on yearly student rankings and competitions, taking into regard their study performance and active engagement in research-oriented project work.

[1] https://lpnu.ua/en/2025

As for the organisational structure, all tasks and responsibilities are clearly defined, and all internal stakeholder groups, including students are involved, for example when it comes to the design and enhancement of study programmes.

2.2 Internationalisation and Student Mobility

According to the self-report, the university strives for the *"full integration of the university into the global educational and research environment"* in order to educate *"high-quality competent professionals for the global labour market" (self-report, part 1, p. 4, "Internationalization Stategy"[2])*

To date, the university has facilitated more than 300 cooperation agreements with higher education institutions, companies and organisations from 31 countries. In 2021 the Erasmus+ programme was implemented enabling student mobility with universities in Germany, Poland, France, Turkey, Lithuania, Romania, Sweden, the United Kingdom, Slovakia, Croatia and the Czech Republic. There are also 38 double degree programmes with EU partner universities available. Other programmes providing student or staff mobility are DAAD programmes, internship programmes ad the "Visit Professor Programme".

For example, the ACS Department ("Information Control Systems and Technologies" study programme) offers semesters abroad for students and short-term exchanges for teachers in cooperation with Kingston University London (UK), and has established a joint research programme with the Vienna University of Technology (Austria). A project under the TEMPUS programme with the Technical University of Nuremberg (Germany) resulted in the establishment of a Centre for Innovative Technologies in Education and the Use of Distance Learning Technologies.

With regard to the study programme "Computer Control Systems for Moving Objects (Automobile Transport)", the report mentions in particular a cooperation with the Polish universities Krakow Polytechnic, Opole Polytechnic and Kielce Polytecnic. Students have had opportunities for internships (Philips Research Laboratories, Eindhove, Netherlands) and student mobility with universities in France and Germany. The Department of Artificial Intelligence offers student mobility opportunities with a number of companies and universities in Poland, Serbia, Italy, Germany, the Czech Republic and Sweden.

Recognition of learning outcomes obtained in other educational institutions is regulated by the "Procedure of Re-enrollment of Academic Disciplines[3]". Previous training or the results of (international) academic mobility can be recognized. In addition, the university developed "Regulations on the Recognition of Learning Outcomes Acquired in Non-formal Education and Informal Learning[4]".

---

[2] https://lpnu.ua/en/lviv-polytechnic/strategy-internationalization-2025
[3]https://lpnu.ua/en/procedure-re-enrollment-enrollment-academic-disciplines-or-other-components-curriculum
[4] https://lpnu.ua/en/regulations-recognition-learning-outcomes-acquired-non-formal-education-and-informal-

Experts' Appraisal

The topic of internationalisation was discussed with students and staff during the online interviews. The university's internationalisation strategy is clearly implemented in all of the study programmes in question, enabling students not only to learn from internationally renowned guest lecturers, but also to take part in a variety of activities with international partner organisations. The self-report provides detailed information on the opportunities for student mobility, staff exchange and international cooperation for the programmes. Also, procedures for recognising learning outcomes gained elsewhere are established and published.

2.3 Teaching Faculty

The university provided detailed lists of teaching staff for each of the programmes in question, as well as curriculum vitae for each lecturer.

According to the self-report 14 lecturers (including 5 full professors) are involved in the study programme "Artificial Intelligence" and 13 lecturers (among them 6 full professors) teach in the programme "Information Control Systems and Technologies". Twelve faculty members (including 4 full professors) participate in the study programme "System Design" and 11 lecturers (including 3 full professors) teach in the study programme "Computer Control Systems for Moving objects (Automobile Transport)".

With very few exceptions (2 professors in "Artificial Intelligence" and "Information Control Systems and Technologies" and one professor in "System Design") all lecturers are employed at the university full-time.

The university provided a description of its procedures and regulations for the competitive selection of teaching staff and for staff development (self-report, part 1, p. 20). In addition, the university has a practice of regularly involving practitioners, industry experts and employer representatives in teaching.

Teachers can improve their skills and do internships both in Ukraine and abroad. The university also has a Department of Personnel Training and Development, which organises training for scientific and scientific-pedagogical personnel. The Centre for Innovative Educational Technologies provides training for pedagogical and scientific-pedagogical staff of Ukraine's educational institutions in 11 areas, including "Information and Communication Technologies in Education" and "Organisation of Distance Learning". Training programmes are also offered by the Institute of Postgraduate Education.

learning

Experts' Appraisal

For the implementation of the programme concepts, the experts consider the staffing levels to be adequate in terms of quantity and quality. The University's excellent staff resources are complemented by regular national and international visiting lecturers from within and outside academia, and the university ensures that students receive qualified training and supervision during internships and projects.

There is no doubt that the lecturers and the management of the Faculty attach great importance to the quality of teaching and to their own professional role as teachers. The research interests of the teaching staff provide students with opportunities to participate in a wide range of research projects.

The experts concluded that the university applies a fair and transparent process for the recruitment and development of staff, and that lecturers/professors are appointed in accordance with national regulations. The process includes competition for posts and involves student representatives. A wide range of training opportunities for lecturers include specialist training from companies in the region.

2.4 Learning Environment and Student Support System

The infrastructure, resources and student services provided at LPNU are described in the self-report. In addition, one of the experts visited the university campus prior to the online talks and reported his findings at the experts' preparatory meeting. The facilities visited covered all four departments involved in the study programmes including classrooms, laboratories, dormitories, shelters, sports and recreational facilities as well as the library, the Center of Veterans Assistance and Development, the Tech Startup School and the Project Office for Innovation and International projects.

By the University's own acount the material and technical base for the education of students consists of 31 educational buildings with the total area of 172,542 m^2: the area of educational premises – 151,130 m^2, premises for research and teaching staff – 16,686 m^2, computer laboratories – 14,893 m^2, office premises – 32,129.5 m^2, sports halls – 6,519 m^2, library with the area of 10,843 m^2. Number of workstations with PCs for students – 5,140, including Internet access – 2,475.

The University's Scientific and Technical Library comprises a reference library, scientific publications, full-text electronic resources, subscriptions and co-working spaces. One of the library's two floors has recently been renovated, while the second floor's renovation had to be postponed due to the war.

According to the self-report the educational environment created at the university provides teachers and students with free access to the infrastructure and information resources necessary for teaching, training and research activities within the educational programmes. Long-term and annual plans for improving and updating the learning material and the technical base are in place[5].

[5] https://lpnu.ua/en/2025

There is free access to WiFi and the "Virtual Learning Environment of Lviv Polytechnic" (VLE LP) and the "electronic student office". Students have full internet access in their dormitories.

The Department of Youth Policy and Social Development[6] (student polyclinic and sports club, health camps, student scientific circles and communities, etc.), coordinates the activities of structural units, student self-government bodies and cooperates with public organizations and parties in the field of youth policy and national-civic education. The purpose of the department, among others, is: to facilitate direct participation of students and to protect socially vulnerable youth, namely students with disabilities, orphans, from large and disadvantaged families.

The university has submitted its "Policy of gender equality and personal development"[7] which states:

"The Policy of gender equality and personal development at Lviv Polytechnic National University […] is designed and implemented to ensure equal human rights and equal opportunities for personal development for all employees and graduates of Lviv Polytechnic National University, regardless of gender, religion, social status, nationality, political and other beliefs."

According to the self-report, LPNU is continuously transforming the university infrastructure into a barrier-free educational space, implementing an inclusive education policy to meet a wide range of educational, informational and social needs of people with disabilities and chronic diseases. The development of inclusive educational services at the university is based on the regular assessment of needs, in particular the needs of people with disabilities, chronic diseases and other special educational needs, including the needs of war veterans, combatants and their families. The Accessibility Service provides continuous support for the educational process of students with disabilities and chronic diseases to the Learning Opportunities "Without Restrictions"[8], which is a division of the International Centre for Professional Partnership "Integration"[9], as well as a multidisciplinary group of leading experts of the University. The procedure for accompanying persons with disabilities and chronic diseases at the university provides the applicant with general information about the University's resources and the availability of services in the field of inclusive education. Each year, after the admissions campaign, the University's Admissions Committee creates a database of people with disabilities and special needs and sends it to the "Without Restrictions" service to create a questionnaire on the special needs of enrolled students.

Support for foreign students is organised by the Department for Foreign Students[10] and the Preparatory Department for Foreign Citizens[11] and includes for example a buddy system[12].

[6] https://lpnu.ua/en/department-youth-policy-and-social-development
[7] https://lpnu.ua/sites/default/files/2022/pages/19397/policy-gender-equality-and-personal-development.pdf
[8] https://lpnu.ua/en/no-limits
[9] https://lpnu.ua/en/integration-center
[10] https://lpnu.ua/en/department-foreign-students
[11] https://lpnu.ua/en/preparatory-department-foreign-citizens
[12] https://lpnu.ua/en/buddy-system

Experts' Appraisal

The experts have come to the conclusion that the students at LPNU are provided with a good environment for both online and offline learning. Infrastructure and equipment are state of-the-art and in good condition. According to the students, student support is well organised and efficient.

The university has a "policy of gender equality" and a concept to support students with health issues. Modern buildings are well equipped for students with mobility issues and according to the online talks, it is the University's goal to equip the older buildings accordingly in the course of the next three years.

A merit-based system of study fees is in place, that allows excellent students to study for free.

2.5 Quality Assurence

The university provided a detailed description of its quality management system including regulations, processes and responsibilities. According to the self-report the procedures and regulations for the development, approval, monitoring and periodic review of study programmes are published on the University's website[13]. In accordance with these regulations, the monitoring of study programmes is carried out at least once a year by the Scientific and Methodological Commission of the Faculty. The purpose of the monitoring is to

- determine whether the study programmes are achieving their objectives and whether
- they are meeting the needs of students, employers and other stakeholders.

Monitoring is carried out by interviewing students, employers and other stakeholders, analysing the results of student assessment and comparing the programme with other related programmes.

The monitoring includes

- an assessment of the consistency of the study programme with the achievements of science in the relevant fields of knowledge and with trends in the economy and society,
- consideration of students' ability to undertake the study programme's workload and acquire the expected competencies,
- the demand on the labour market for specialists who have obtained a higher education in the field of the study programme in question.

Once a year an audit team is formed, which conducts an internal audit of the university's quality management system (QMS). On the basis of the findings, the management of the university carries out a SWOT analysis identifying strengths and weaknesses, opportunities and threats. In turn, the heads of departments develop goals in the field of quality and identify risks and risk management measures for the current year.

In 2020 the Center for Quality Assurance in Education (CQAE) was established to monitor procedures

[13] https://lpnu.ua/en/documents

and processes of the internal system of quality assurance as well as the quality of study programmes and to analyse the educational achievements of students. Furthermore, the CQAE provides recommendations about possible improvements with respect to the quality management process or to study programmes itself, if weaknesses have been identified. Conducting systematic stakeholder surveys is another important area.

Experts' Appraisal

Based on the written and oral information provided, the experts are confident that LPNU has established a well-functioning quality management system.

The university has assigned clear internal responsibilities for quality assurance and has developed effective and reliable procedures for the management and development of study programmes.

LNPU makes use of a variety of instruments for the continuous monitoring and review of its programmes. Course evaluations, evaluation on students' workload as well as graduates' feedback surveys are conducted on a regular basis. Apart from written surveys, these also include the analysis of performance indicators.

Students reported that they felt their voice was heard and that teachers were open to their feedback.

Another particularly strong point is the tight network between the university and the employment market. Businesses from the region and beyond accept students for internships, stay in touch with the university on a permanent basis and provide regular feedback on the study programmes in general.

The involvement of students, enterprises and other stakeholders in the evaluation processes, in particular the annual review of study programmes, enables the university to continuously adapt and develop its study programmes.

2.6 Transparency and Public Information

The university provided a list of the most important regulations and procedures on university level and for the study programmes in questions. All key information on the university, the faculty and the study programmes (intended learning outcomes, profile, contents, course syllabi, etc.) can be found on the website. A compilation of rules and regulation in English language is available on the website[14] as well.

According to the self-report, *"Communication with students [is] done by bringing the necessary information to students both directly by teachers during classes, consultations and educational hours, and with the use of modern information technology. In particular, the official website of the university has all the necessary information for higher education about the organization of the educational process, the content of study programs and individual educational components, schedule, schedule,*

[14] https://lpnu.ua/en/documents

current academic mobility, participation in applications for grant and scholarship programs, competitions, conferences, etc. In addition, applicants for higher education and other participants in the educational process have access to all regulations of the University. In the special section of the site dedicated to students, there is information about the student body, trade union of students and graduate students, student department and campus, student clinic and sports club, health camps, student research clubs and communities and more."

Additional information ("information package"[15]) for prospective students can be found online in English language.

Experts' Appraisal

The experts commend the university on the high level of transparency. For all enrolled students, maximum transparency regarding course requirements and assessment procedures is warranted. Information for prospective students on content of the study programmes and administrative procedures is provided as well. The internship, mandatory for the study programmes under consideration, is regulated in detail in by the "Regulation on Organization of Student Practical Training[16]" and involves the Department of Employment and Industrial Relations[17]. Students are well informed about the internship and following the experts' recommendation during the online talks, a description of the internships has been included in the module handbook (syllabi).

Graduates of the study programmes receive a Diploma Supplement in line with European standards and requirements.

[15] https://lpnu.ua/en/education/information-package
[16] https://lpnu.ua/sites/default/files/2020/pages/2008/hes-lp-0204.pdf
[17] https://lpnu.ua/en/regulation-department-employment-and-industrial-relations

3. Assessment of the Study Programmes

3.1 Common Features and Strategic Dimension of the Programmes

Key Data and Background Information

The programme with the longest history of the programmes in question is the study programme "Information Control Systems and Technology". Its origin dates back nearly 50 years ago, when the "Department of Automated Control Systems (ACS)" was one of the first, not only at Lviv Polytechnic, but also in the whole country to start training specialists in the field of implementation of computer technology and automated control systems. Since then more than 4,000 graduates of the department have been employed in Ukrainian and international IT companies. Among them are 160 graduates from 19 foreign countries.

Since then new research directions (e.g. "technologies of transformation of speech signals structure", "databases", "neural networks", "intelligent information technologies for control" and "smart systems and technologies") have been pursued. With the start of the master's programme "Computer Information Processing and Control" in 1994 the department introduced the two-level training system (bachelor, master). In the 2000s this programme was transformed into the "Information Control Systems and Technologies" master's programme to keep up with the changing IT market.

All four study programmes have strong links with the Lviv IT Cluster[18], a community of IT companies, authorities and educational institutions dedicated to working for the development of the IT sector and the Lviv region through education, industry promotion and infrastructure. Since the early 1990s the first Ukrainian IT companies have been established in the Lviv region, and the number of IT companies has grown to 511 by the year 2021[19] creating a growing demand for IT specialists in the region[20] (self-report, part 2 "Information Control Systems and Technologies", p. 6).

"The turnover of the IT industry in Lviv alone is 14.4% of Lviv's GDP. The 6 largest IT companies (SoftServe, EPAM, ELEKS, GlobalLogic, N-iX and Intellias) have more than 10,000 employees in the western Ukrainian location. Another 17 companies have about 5,000 employees (Symphony Solutions, Edvantis Software, Perfectial, CoreValue, Conscensia, Skelia, DevCom, ISD, Lohika, EricPol, DataArt, Cyclum, Sigma Software, Mita-Teknik, Cypress Semiconductor, ZoomSupport). In the Western region of Ukraine there are offices of world-famous Oracle and Siemens, as well as a number of other well-known international IT companies that create their own products." (self-report, part 2, "Artificial Intelligence, p. 4).

According to the self-report and the online talks representatives of the IT cluster and other employers in the region are involved in the development and quality management of the study programmes, provide internships, lecturers or practical training.

[18] https://itcluster.lviv.ua/en/about-cluster/
[19] https://ain.ua/en/2021/12/29/lviv-it-industry-research-results/
[20] https://itcluster.lviv.ua/en/projects/it-research/

Together with the Lviv IT Cluster, the Department of Computerised Automation Systems developed a study programme in 2015 to train specialists in the field of computer control systems (today: "Computer Control Systems for Moving Objects (Automobile Transport)". The first students enrolled a year later, in 2016. According to the self-report the study programme "System Design" was launched in 2002. At the same time the study programme "Artificial Intelligence" was developed as a specialisation for the specialty "Computer Science" and two years later, in 2004 the first students were enrolled.

General Structural Features

All four study programmes considered here are three-semester (90 ECTS credit points) full-time master's programmes. One ECTS credit point equals 30 hours of student workload (self-report[21], part 1, p. 9). According to the self-report the ratio of contact classroom hours and hours devoted to independent work of the students is 30/70.

The university differentiates between "general training" (two mandatory modules ("Information Marketing and Management" (3 ECTS) and "Innovative Information Technologies" (3 ECTS), the four study programmes have in common), mandatory "professional training" (specialised modules for the individual study programmes" and "elective group"/"block of disciplines" modules (from a pre-selected list of modules, that can be chosen by the students in order to specialise in a certain direction). In compliance to Ukrainian regulations all study programmes include at least 25 % ECTS gained in elective courses (self-report, p. 10). At least 20 % of these ECTS have to be gained by choosing from a "block of disciplines" (profile) within the study programme. An additional 5 % are gained from selecting other individual modules that the students choose from a list, approved by the scientific and methodological council and made available on the website.

The third and last semester is dedicated to the master's theses, containing of the elements "Internship on the Master's theses" (9 ECTS), "Preparation of the Master's theses" (16,5 ECTS) and "Defense of the Master's theses" (4,5 ECTS).

Admission to the Programmes

Information on admissions and entry requirements is updated annually and published on the university's website. On the basis of the university's admission rules, an entrance examination agenda is drawn up separately for each subject and published on the university's website. The selection of entrants to master's programmes is based on a score. It is calculated as the sum of the average score of the bachelor's degree supplement, the number of additional points for scientific and pedagogical achievements and the entrance exam scores (self-report, p. 8).

[21] and "Regulations on the Organization of the Educational Process" (Appendix (Basic terms and their defnitions)), https://lpnu.ua/sites/default/files/2020/pages/2005/hes-lp-0201.pdf

Methods of Teaching and Assessment

To achieve the set learning outcomes, the study programmes use a combination of formats and methods of trainings: lectures, individual or team practical work, seminars with discussions, laboratories with a combination of scientific work and discussions, implementations of course projects, workshops, use of the electronic learning and methodical complexes (VNS[22]) in the Moodle environment. Teaching is carried out with the active use of multimedia tools and specialized software. In VNS for students have access to information about each educational component (author of the course, recommended literature, assessments, lecture notes, methodical recommendations for laboratory, practical and course projects, test tasks for self-assessment, etc.).

The self-report gives numerous examples of students being successfully involved in research projects both nationally and internationally (e.g. conferences and papers). The planning, organisation and control of the research work of the students is regulated by the "Regulations on Research Work of University Students". The combination of teaching and research is implemented in the course projects and master's theses, which include the solution of scientific problems, as well as the scientific solution of applied problems during the internship and practice of the master's thesis. One of the requirements for admission of a student to the defence is the existence of a publication in conference proceedings or the publication of a scientific article.

Forms of assessment of academic performance include continuous assessment during lectures, practical sessions, laboratories, seminars and individual tutorials to check the level of students' theoretical and practical knowledge and skills and to ensure students' motivation for systematic active work throughout the period of study.

In addition, there is a final examination in each subject at the end of the semester. This can be either an exam taken by the end of the term or a "credit", assessing the student's educational material assimilation in a particular discipline in total for all types of work provided for in the work program of the discipline (see Regulations on the Organization of the Educational Process[23], 5.1.3.).

Experts' Appraisal

The experts welcome the clear and well considered structure of the programmes, which offers the students a remarkable freedom of choice. Students can not only choose a pathway within their programme, but can also develop individual profiles, by their own choosing, thereby enhancing their career prospects. At the same time an evenly distributed manageable workload is maintained.

The experts commend the university on their variety of innovative teaching and assessment methods. With the opportunities arising from the cooperation with a huge number of national and international companies in the region, the university ensures a current, hands-on and practical education while at

[22] http://vns.lpnu.ua
[23] https://lpnu.ua/sites/default/files/2020/pages/2005/hes-lp-0201.pdf

the same time involving students in research.

3.2 Information Control Systems and Technologies

3.2.1 Intended Learning Outcomes

The programme's intended learning outcomes are listed in the university's documentation and described in detail in the self-report.

According to the self-report the study programme *"offers students a broad foundation in modern software and hardware systems and an in-depth knowledge of the new applications of IT. It is aimed at developing better career opportunities and increasing knowledge in the field of computer science and modern IT. The programme is designed, first of all, for persons who already have a bachelor's degree in Computer Science, but it is also suitable for a wide range of individuals with expertise and bachelor's degrees in various areas (self-report, part 2 "Information Control Systems and Technologies", p. 1).*

The study programme *"deals with both the theoretical and the practical aspects, is constantly improved in accordance with current trends in digital technologies. The programme covers the latest technologies and their applications to the cloud and mobile apps, smart systems, etc. Students will develop a comprehensive knowledge of the fundamentals of software development and information management and an in-depth understanding of computational intelligence principles and technologies, optimization techniques, data protection, reliability issues, etc." (ibid. p. 2).*

The main focus of the study programme according to the university is *"the research and development of methods and tools for the intellectualization of information control systems and technologies using computational intelligence, data mining techniques, artificial neural networks, adaptive control, signal and image processing, parallel computing, etc. The programme is oriented towards the application and implementation of innovative software and hardware components, network solutions and smart technologies in different industries." (ibid. p. 3).*

At the same time the programme *"is heavily geared towards developing students' professional skills needed for employment, while being able to adapt to rapidly changing technology, to work effectively, professionally and ethically in computing-related professions, as demonstrated by their communications, teamwork and leadership skills. Graduates are expected to have developed the professional skills necessary for a senior career in the IT industry, as well as critical thinking and evidential reasoning, engineering judgement in the decision-making process and the ability to systematically analyse problems and implement effective solutions." (ibid. p. 1)*

Possible occupations as listed in the self-report include project manager, software architect, software engineer, embedded software engineer, DevOps engineer, Business analyst, data scientist, (big) data engineer, hardware engineer, quality assurance engineer, cyber security engineer, account (sales)manager, engagement engineer, HR manager (ibid. p.8).

3.2.2 Structure and Content

The first semester comprises the mandatory "general training" modules "Information Marketing and Management" (3 ECTS) and "Innovative Information Technologies" (9 ECTS) as well as the mandatory "professional training" modules "Control and Decision Support in Complex Systems" (5 ECTS), "Problem-oriented and Embedded Computer Systems" (5 ECTS), "Next Generation Networks and Data Protection" (5 ECTS) and "Professional and Civil Security" (3 ECTS).

For the second semester the "professional training" module "Computational Intelligence Technologies" (5 ECTS) is mandatory. In addition, either the elective modules from the profile ("elective group") "Intelligent Control Systems and Technologies" or from the profile " Specialized real-time Information Technologies" and two additional elective components (3 and 5 ECTS) can be chosen.

Modules for the elective profile "Intelligent Control Systems and Technologies" (17 ECTS) are:

- "Integrated Hierarchical Control Systems" (5 ECTS)
- "Mathematical Models for System's Syntheseis and Optimization" (5 ECTS)
- "Industrial Internet of Things" (5 ECTS)
- "Integrated Hierarchical Control Systems (course work)" (2 ECTS).

Modules for the elective profile "Specialised real-time Information Technologies" (17 ECTS) are:

- "Computerised Systems of Digital Signal Image Processing" (5 ECTS)
- "Reliability of Systems and Software" (5 ECTS)
- "Computer Vision Systems" (5 ECTS)
- "Computer Vision Systems (course work)" (2 ECTS).

The study programme is concluded with finishing the master's theses (see above for details).

Experts' Appraisal

The experts fully support the overall profile and design of the Masters programme. In terms of the stated objectives and intended learning outcomes, the curriculum is convincing and plausible with a good balance between compulsory and elective courses and an appealing mix of topics. As far as the experts can see, the credits awarded for the different components of the curriculum are in line with the course requirements.

The experts have no doubt that the programme fulfils its central objective of preparing students for the national and international labour market and for further study.

3.3 System Design

3.3.1 Intended Learning Outcomes

The programme's intended learning outcomes are listed in the university's documentation and

described in the self-report. According to the self-report: *"The mission of the Study Programme "System Design" is to grow specialists who combine multidisciplinary knowledge of programming, modelling, design and production of state-of-art information systems to solve problems with social and economic impact.*

The vision of the Study Programme is to provide students with in-depth theoretical and practical knowledge, skills and understanding related to system design concepts. Those skills will enable students to effectively perform innovative tasks of the appropriate professional activity level and develop information systems for science and business needs." (self-report, part 3 "System Control", p.1)

"The basic idea of the Study Programme is to combine programming and design of information systems within the specialty of Computer Science. Based on the learning outcomes, students should be able to develop and maintain innovative products. It is significant for companies interested in developing and promoting their products in the national and international markets. Areas of interest to such professionals are the IT industry, the financial sector, transport, agriculture, industry, services, and public administration. […]"

"The first soft skill (LO1) is the ability to work in a team, understand what responsibility is, and share it among all team members. In the future, this soft skill may upgrade to management skills. It will be relevant for those graduates who will become middle and senior managers, technical directors, and more. The second soft skill (LO2) is the ability to think critically and apply critical thinking to find the latest non-standard technical solutions. The third soft skill (LO3) is the ability to express one's opinion orally and in writing and to lead a professional discussion at a high professional level." (self-report, part 2 "System Control", p.1)

3.3.2. Structure and Content

The first semester comprises the mandatory "general training" modules "Information Marketing and Management" (3 ECTS) and "Innovative Information Technologies" (9 ECTS) as well as the mandatory "professional training" modules "Methods and Tools for Machine Learning" (5 ECTS), "Professional ad Civil Security" (3 ECTS), "Pattern Recognition and Computer Vision" (5 ECTS) and "Semantic Web and Grid Networks" (5 ECTS).

In the second semester the "professional training" module "Methods of Designing Multiagent Systems" (5 ECTS) is mandatory. Apart from choosing a module from the cycle of "general training" (3 ECTS) and one module from another study programme's "professional training" module (5 ECTS), student choose either the profile ("line") "System Design" or the profile "Integrated Technologies of System Design of Micro- and Nanosystems".

Modules for the elective profile "System Design" (17 ECTS) are:

- "Design Automation for Embedded Systems" (5 ECTS)
- "Computer-Aided Design for User Interfaces" (7 ECTS)
- "Computer-Aided Design for Decision Support Systems" (5 ECTS)

Modules for the elective profile "Integrated Technologies of System Design of Micro- and Nanosystems" (17 ECTS) are:

- "Progressive Methods for Design and Production of Micro/Nano Systems" (5 ECTS)
- "Progressive Micro/Nano Technologies" (5 ECTS)
- "Extended Design of Microsensors and Microactuators" (7 ECTS)

The study programme is concluded with finishing the master's theses in the third semester (see above for details).

Experts' Appraisal

The overall profile and design of the Masters programme is fully supported by the experts.

With regard to the stated objectives and intended learning outcomes, the curriculum is convincing and plausible, with a good balance between compulsory and optional courses and an attractive mix of topics.

The credits awarded for the different components of the curriculum are in line with the course requirements, as far as the experts can see.

The experts do not doubt that the programme meets its central objective of preparing students for the national and international labour market and for further study.

3.4 Artificial Intelligence

3.4.1 Intended Learning Outcomes

The programme's intended learning outcomes are listed in the university's documentation and described in the self-report: *"The study programme "Artificial Intelligence" […] focuses on training a specialist responsible for algorithmically complex problem solving, large volumes of data analysing, video processing, images or texts analysing, programming and controlling robots.*

The programme covers promising areas of computer modelling processes to develop modern software packages and decision support systems, deep knowledge of artificial intelligence systems. Emphasis is also placed on modelling natural language analysis systems. Structural and object-oriented approaches to software design are being developed.

The mission of the study programme is to provide students with in-depth theoretical and practical knowledge, skills and understanding related to the field of artificial intelligence. Those skills will enable students to effectively perform innovative tasks of the appropriate professional activity level and develop information systems for science and business needs in various fields. […]

The main focus of the study programme is in-depth knowledge of artificial intelligence systems and methods of natural language processing, as well as the ability to use them in information systems design. In the MSAI program, students learn to apply creative thinking, algorithmic design, and coding

skills to build modern AI systems. This is also facilitated by the presence of the "Lviv Polytechnic Science Park", Technical Startup School, Research and Training Production Center of the Institute of Computer Science and Information Technology, research laboratories. […]

Intended Learning Outcomes are built for students' ability to solve new or unfamiliar situations (environments) in broad (or interdisciplinary) contexts." (self-report, part 2 "Artificial Intelligence" p.1-2).

Typical jobs for graduates according to the self-report (ibid. p. 5) are data scientist, big data engineer, Machine learning engineer, MLOps engineer, backend developer and system business analyst. (ibid. p. 5).

3.4.2 Structure and Content

The first semester comprises the mandatory "general training" modules "Information Marketing and Management" (3 ECTS) and "Innovative Information Technologies" (9 ECTS) as well as the mandatory "professional training" modules "Machine Learning" (5 ECTS), "Professional ad Civil Security" (3 ECTS), "Big Data Analysis Methods" (5 ECTS) and "Deep Learning Systems Design" (5 ECTS).

In the second semester the "professional training" module "Artificial Intelligence in Games" (5 ECTS) is mandatory. Student choose either the profile ("line") "Deep Learning" or the profile "Artificial Intelligence".

Modules for the elective profile "Deep Learning" (17 ECTS) are:

- "Intelligent Text Analyses and Tonality Analyses" (5 ECTS)
- "Deep Learning Modelling and Optimisation" (7 ECTS)
- "Image Processing Based on Artificial Intelligence Methods" (5 ECTS).

Modules for the elective profile "Artificial Intelligence" (17 ECTS) are:

- "Web Mining" (5 ECTS),
- "Data Visualisation" (5 ECTS),
- "Evolutionary Programming" (7 ECTS),

The study programme is concluded with finishing the master's theses in the third semester (see above for details).

Experts' Appraisal

The overall profile and design of the Masters programme is fully supported by the experts.

With regard to the stated objectives and intended learning outcomes, the curriculum is convincing and plausible, with a good balance between compulsory and optional courses and an attractive mix of topics.

The credits awarded for the different components of the curriculum are in line with the course requirements, as far as the experts can see.

The experts do not doubt that the programme meets its central objective of preparing students for the national and international labour market and for further study.

3.5 Computer Control Systems for Moving Objects (Automobile Transport)

3.5.1 Intended Learning Outcomes

The programme's intended learning outcomes are listed in the university's documentation and described in the self-report: *"In support of the university's mission, the Master of Science in Computer Control Systems for Moving Objects (Automobile Transport) (CCSMO) is designed for a wide range of people involved in transportation systems. The programme combines theory with practice, offers a wide range of traditional and state-of-the-art courses and provides the necessary flexibility for students with diverse backgrounds, including professionals who want to expand their understanding of computer systems transport management. of Science, but wish to expand their knowledge in this field.*

Educational and professional programme "Computer control systems for moving objects (road transport)" […] aims to train a specialist who can solve algorithmically complex problems, analyse large amounts of data , develop algorithms for processing video, images or one-dimensional data, programming and control of moving objects.

The programme develops promising areas for the introduction of information technology in road transport, as well as modern technologies in the field of the Internet of Things in transport. Emphasis is also placed on digital methods of signal processing and image analysis, modelling of computer control systems for moving objects. Structural and object-oriented approaches to hardware and software design are being developed.

The purpose of the educational programme is to provide students with deep theoretical knowledge and practical skills, as well as understanding related to the development of computer control systems in road transport, which will effectively perform innovative tasks of the appropriate level of professional activity and develop information systems for science and different industries. […]

The main direction of the educational programme and specialization is deep knowledge in the field of computer systems for measurement, control and diagnostics in transport, methods of digital information processing, artificial intelligence, as well as the ability to use them to design and programme onboard computer systems. According to this program, students learn to use creative thinking, approaches to hardware and software development, gain skills to create modern on-board intelligent systems. This is also facilitated by the presence of the Lviv Polytechnic Science Park, a technical startup school, and research laboratories. […]

Intended Learning Outcomes are built for students' ability to solve new or unfamiliar situations (environments) in broad (or interdisciplinary) contexts." (self-report part 2, 3.5 Computer Control Systems for Moving Objects (Automobile Transport)p. 1-2).

Possible occupations for graduates according to the self-report (ibid. p.4) are engineer of diagnostics and repair of automotive electronics or engineer for the design of modern car control systems.

3.5.2 Structure and Content

The first semester comprises the mandatory "general training" modules "Information Marketing and Management" (3 ECTS) and "Innovative Information Technologies" (9 ECTS) as well as the mandatory "professional training" modules "Car Electrical and Electronic Equipment" (7 ECTS), "Computerised Control and Diagnostics Systems in Transportation" (8 ECTS), "Professional ad Civil Security" (3 ECTS).

In the second semester the "professional training" module "Design and Programming of the Onboard Computer Systems" (7 ECTS) is mandatory. Student choose either the profile ("line") "Internet of Things of Transport" or the profile "Industrial Internet of Things".

Modules for the elective profile "Internet of Things on Transport" (15 ECTS) are:

- "Digital Signal Processing and Image Analysis" (5 ECTS)
- "Automotive Sensor Systems" (5 ECTS)
- "Modern Electronic Car Technologies" (5 ECTS).

Modules for the elective profile "Industrial Internet of Things" (15 ECTS) are:

- "Design and Programming of Automation System Controllers" (5 ECTS),
- "Digital Signal Processing in IoT Systems" (5 ECTS),
- "Artificial Intelligence for Robotic Systems" (5 ECTS).

The study programme is concluded with finishing the master's theses in the third semester (see above for details).

Experts' Appraisal

The experts fully embrace the overall profile and concept of the master's programme. With a view to the formulated objectives and intended learning outcomes, the curriculum is designed in a convincing and plausible way, offering a good balance of mandatory and elective courses and an appealing mixture of topics. However, since the subject of PLCs is more relevant to production than to moving objects as such, the experts recommend making this module optional and suggest including a course on Kalman filtering instead.

As far as the experts can see, the credits awarded for the individual curricular components are in line with the course requirements.

The experts have no doubt that the programme fulfils its central goal of preparing students for the national and international labour market and academia as well.

- Recommendation: Since the topic PLC is rather relevant production but not in moving objects as such, the experts recommend making this module optional and suggest including a course in Kalman filtering instead.

Appendix

1. Statement of the University in Response to the Expert Report

Lviv Polytechnic National University (LPNU) extends its gratitude to the Central Evaluation and Accreditation Agency (ZEvA) for the efficient organization and supportive communication during the international accreditation of the Cluster Computer Science programs: Information Control Systems and Technologies, System Design, Artificial Intelligence, and Computer Control Systems for Moving Objects (Automobile Transport).

We also thank the Expert Panel for their objective and impartial evaluation of these study programs. The constructive recommendations and proposals provided by the expert group during the online site visit and documented in the Accreditation Report have been carefully considered and will be implemented to enhance the quality of higher education at our university.

The expert recommendations are invaluable and will be fully integrated into the university's future development and educational programs. The experts provided a precise and comprehensive assessment of all aspects of the university's activities and educational programs.

We fully agree with the recommendation for the study program "Computer Control Systems for Moving Objects (Automobile Transport)." Since the topic of PLC is more relevant to production than to moving objects, the experts recommend making this module optional. Instead, they suggest including a course in Kalman Filtering. Starting next academic year, we will implement this recommendation by introducing a chapter on Kalman Filtering in the course "Digital Signal Processing and Image Analysis."

Additionally, while preparing documents and collaborating with experts, we re-evaluated our "System Design" educational program. This critical review led us to implement changes to better achieve the program's goals. Specifically, we replaced the general education course "Professional and Civil Security" with "Professional English." Given the globalization of the labor market and integration with the European community, this change is essential.

In the future, we plan to update the name and content of the elective profile "Integrated Technologies of System Design of Micro- and Nanosystems." We are considering introducing courses related to virtual and augmented reality technologies. We have already acquired the necessary equipment for training and are in the process of preparing specialists in this field.

We are grateful to the Central Agency for Evaluation and Accreditation and the Expert Group for their thorough analysis of the accredited educational programs, as well as for the high assessment of their quality and the overall educational process at our university. Receiving evaluations and recommendations from international experts is one of the key goals of international accreditation. This approach helps us to enhance the quality of educational services for our students in accordance with European standards and guidelines for quality assurance in higher education (ESG).

Best regards,

Oleh Matviykiv, First Vice-Rector of Lviv Polytechnic National University

В цьому документі прошнуровано, пронумеровано та скріплено печаткою 27 (двадцять сім) аркушів.
Копія відповідає оригіналові.

Перший проректор
Національного університету
«Львівська політехніка» **Олег МАТВІЙКІВ**