Uchwała Nr 19/2020
Senatu Politechniki Łódzkiej
z dnia 30 marca 2020 r.

w sprawie ustalenia programu kształcenia
w Interdyscyplinarnej Szkole Doktorskiej Politechniki Łódzkiej

Na podstawie art. 28 ust. 1 pkt 12, art. 200 ust. 3 i art. 201 ust. 4 ustawy z dnia 20 lipca 2018 r. – Prawo o szkolnictwie wyższym i nauce (t.j. Dz. U. z 2020 r. poz. 85, z późn. zm.) uchwala się, co następuje:

§ 1. Ustala się program kształcenia w Interdyscyplinarnej Szkole Doktorskiej Politechniki Łódzkiej, stanowiący załącznik do uchwały.

§ 2. Uchwała wchodzi w życie z dniem 30 marca 2020 r.

Rektor
Politechniki Łódzkiej

prof. dr hab. inż. Sławomir Wiak

Program kształcenia
w Interdyscyplinarnej Szkole Doktorskiej Politechniki Łódzkiej

§ 1
Podstawowe założenia

1. Kształcenie w Interdyscyplinarnej Szkole Doktorskiej Politechniki Łódzkiej (ISD PŁ) jest prowadzone w oparciu o program kształcenia oraz indywidualny plan badawczy.
2. Kształcenie w ISD PŁ przygotowuje do uzyskania stopnia doktora i kończy się złożeniem rozprawy doktorskiej w terminie określonym w indywidualnym planie badawczym.
3. Ukończenie kształcenia w ISD PŁ umożliwia doktorantowi osiągnięcie efektów uczenia się dla kwalifikacji na poziomie ósmym Polskiej Ramy Kwalifikacji dla dyscypliny lub dziedziny, w ramach której powstaje rozprawa doktorska, określonych w Rozporządzeniu Ministra Nauki i Szkolnictwa Wyższego z dnia 14 listopada 2018 r. w sprawie charakterystyk drugiego stopnia efektów uczenia się dla kwalifikacji na poziomach 6-8 Polskiej Ramy Kwalifikacji (Dz. U. z 2018 r. poz. 2218).
4. Kształcenie w ISD PŁ stwarza warunki do:
   1) prowadzenia samodzielnych badań naukowych oraz współpracy naukowej w zespołach badawczych;
   2) przygotowania przez doktoranta publikacji naukowych i wniosków o finansowanie projektów naukowych, badawczych oraz wdrożeniowych;
   3) przygotowania do egzaminu doktorskiego oraz przygotowania rozprawy doktorskiej pod opieką promotora, promotorów lub promotora i promotora pomocniczego;
   4) uczestniczenia w życiu środowiska naukowego w kraju i za granicą;
   5) uzyskania efektów uczenia się dla kwalifikacji na poziomie 8 Polskiej Ramy Kwalifikacji oraz nabycia innych umiejętności oraz doświadczenia związanego z realizacją programu kształcenia i indywidualnego planu badawczego.
5. Program kształcenia w ISD PŁ jest prowadzony w 12 dyscyplinach wiodących (tzw. ścieżek kształcenia), zgodnie z poniższą listą:

I. W dziedzinie nauk inżynieryjno-technicznych:
   1. Inżynieria materiałowa
   2. Inżynieria mechaniczna
   3. Automatyka, elektronika i elektrotechnika
   4. Informatyka techniczna i telekomunikacja
   5. Inżynieria lądowa i transport
   6. Architektura i urbanistyka
   7. Inżynieria chemiczna

II. W dziedzinie nauk ścisłych i przyrodniczych:
   8. Nauki chemiczne
   9. Matematyka
   10. Nauki fizyczne

III. W dziedzinie nauk rolniczych:
   11. Technologia żywności i żywienia

IV. W dziedzinie nauk społecznych:
   12. Nauki o zarządzaniu i jakości

6. Podstawa programowa w danej dyscyplinie (tzw. „core curriculum and entrepreneurship – CCE") obejmuje:
   1) *Podstawę programową dla danej dyscypliny* (8 ECTS);
   2) *Przedmiot Przedsiębiorczość* (1 ECTS).
7. Program kształcenia może przewidywać odbywanie praktyk zawodowych w formie prowadzenia zajęć lub uczestniczenia w ich prowadzeniu, w wymiarze nieprzekraczającym 60 godzin dydaktycznych rocznie. Zasady realizacji praktyk zawodowych określa Regulamin ISD PŁ.
8. Doktorant w ramach realizacji programu kształcenia uczestniczy w seminarium. Zasady realizacji seminarium określa Regulamin ISD PŁ.
9. W wyniku realizacji kształcenia w Interdyscyplinarnej Szkole Doktorskiej Politechniki Łódzkiej, doktorant osiąga następujące efekty uczenia się:

Wiedza - zna i rozumie:	
Zakres i głębia – kompletność perspektywy poznawczej i zależności	1. w stopniu umożliwiającym rewizję istniejących paradygmatów – światowy dorobek, obejmujący podstawy teoretyczne oraz zagadnienia ogólne i wybrane zagadnienia szczegółowe – właściwe dla danej dyscypliny naukowej; 2. główne tendencje rozwojowe dyscyplin naukowych, w których odbywa się kształcenie; 3. metodologię badań naukowych zasady upowszechniania wyników działalności naukowej, także w trybie otwartego dostępu.
Kontekst – uwarunkowania i skutki	1. fundamentalne dylematy współczesnej cywilizacji; 2. ekonomiczne, prawne, etyczne i inne istotne uwarunkowania działalności naukowej; 3. podstawowe zasady transferu wiedzy do sfery gospodarczej i społecznej oraz komercjalizacji wyników działalności naukowej i know-how związanego z tymi wynikami.
Umiejętności – potrafi:	
Wykorzystanie wiedzy – rozwiązywane problemy i wykonywane zadania	1. wykorzystywać wiedzę z różnych dziedzin nauki lub dziedziny sztuki do twórczego identyfikowania, formułowania i innowacyjnego rozwiązywania złożonych problemów lub wykonywania zadań o charakterze badawczym, a w szczególności: a. definiować cel i przedmiot badań naukowych, formułować hipotezę badawczą, b. rozwijać metody, techniki i narzędzia badawcze oraz twórczo je stosować, c. wnioskować na podstawie wyników badań naukowych; 2. dokonywać krytycznej analizy i oceny wyników badań naukowych, działalności eksperckiej i innych prac o charakterze twórczym oraz ich wkładu w rozwój wiedzy; 3. transferować wyniki działalności naukowej do sfery gospodarczej i społecznej.
Komunikowanie się – odbieranie i tworzenie wypowiedzi, upowszechnianie wiedzy w środowisku naukowym i posługiwanie się językiem obcym	1. komunikować się na tematy specjalistyczne w stopniu umożliwiającym aktywne uczestnictwo w międzynarodowym środowisku naukowym; 2. upowszechniać wyniki działalności naukowej, także w formach popularnych; 3. inicjować debatę; 4. uczestniczyć w dyskursie naukowym; 5. posługiwać się językiem obcym na poziomie B2 Europejskiego Systemu Opisu Kształcenia Językowego w stopniu umożliwiają cym uczestnictwo w międzynarodowym środowisku naukowym i zawodowym.
Organizacja pracy – planowanie i praca zespołowa	1. planować i realizować indywidualne i zespołowe przedsięwzięcia badawcze lub twórcze, także w środowisku międzynarodowym.
Uczenie się – planowanie własnego rozwoju i rozwoju innych osób	1. samodzielnie planować i działać na rzecz własnego rozwoju oraz inspirować i organizować rozwój innych osób; 2. planować zajęcia lub grupy zajęć i realizować je z wykorzystaniem nowoczesnych metod i narzędzi.
Kompetencje społeczne - jest gotów do:	
Oceny – krytyczne podejście	1. krytycznej oceny dorobku w ramach danej dyscypliny naukowej lub artystycznej; 2. krytycznej oceny własnego wkładu w rozwój danej dyscypliny naukowej lub artystycznej; 3. uznawania znaczenia wiedzy w rozwiązywaniu problemów poznawczych i praktycznych.
Odpowiedzialność – wypełnianie zobowiązań społecznych i działanie na rzecz interesu publicznego	1. wypełniania zobowiązań społecznych badaczy i twórców; 2. inicjowania działań na rzecz interesu publicznego; 3. myślenia i działania w sposób przedsiębiorczy.
Rola zawodowa – niezależność i rozwój etosu	1. podtrzymywania i rozwijania etosu środowisk badawczych i twórczych, w tym prowadzenia działalności naukowej w sposób niezależny i respektowania zasady publicznej własności wyników działalności naukowej, z uwzględnieniem zasad ochrony własności intelektualnej.

§ 2
Indywidualny plan kształcenia

1. W uzasadnionych przypadkach, np. doktorantów realizujących program Ministra Nauki i Szkolnictwa Wyższego „Doktorat wdrożeniowy” lub realizujących interdyscyplinarną pracę doktorską przy współudziale dwóch promotorów z różnych dyscyplin, możliwe jest prowadzenie indywidualnego planu kształcenia (IPK).
2. IPK umożliwia wybór zajęć wchodzących w zakres podstawy programowej, przedmiotów obieralnych oraz innych przedmiotów, w tym realizowanych w formie projektów indywidualnych lub grupowych, również o charakterze interdyscyplinarnym.
3. Doktorant w ścisłej współpracy z promotorem, promotorami lub promotorem i promotorem pomocniczym opracowuje IPK bazując na podsiadanym wykształceniu i kompetencjach, założeniach i celach doktoratu, wymogach kwalifikacji dla poziomu 8 PRK oraz wymogach zawartych w regulaminie ISD PŁ.
4. Realizacja IPK umożliwia doktorantowi osiągnięcie efektów uczenia się dla kwalifikacji na poziomie ósmym Polskiej Ramy Kwalifikacji dla dyscypliny lub dziedziny, w ramach której powstaje rozprawa doktorska.

§ 3
Opis ścieżek kształcenia

Lista załączników do Programu kształcenia w ISD PŁ:

1) Załącznik nr 1 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Inżynieria materiałowa;
2) Załącznik nr 2 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Inżynieria mechaniczna;
3) Załącznik nr 3 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Automatyka, elektronika i elektrotechnika;
4) Załącznik nr 4 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Informatyka techniczna i telekomunikacja;
5) Załącznik nr 5 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Inżynieria lądowa i transport;
6) Załącznik nr 6 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Architektura i urbanistyka;
7) Załącznik nr 7 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Inżynieria chemiczna;
8) Załącznik nr 8 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Nauki chemiczne;
9) Załącznik nr 9 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Matematyka;
10) Załącznik nr 10 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Nauki fizyczne;
11) Załącznik nr 11 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Technologia żywności i żywienia;
12) Załącznik nr 12 do Programu Kształcenia w ISD PŁ – ścieżka kształcenia w dyscyplinie Nauki o zarządzaniu;

TRAINING PROGRAM IN DISCIPLINE:
Materials Engineering

1. Basic information

Domain: Engineering and Technology
Discipline: Materials Engineering
Degree awarded: PhD in Materials Engineering

2. Training demand

PhD training in the field of Materials Engineering prepare graduates for an employment in scientific laboratories, research and development establishments, universities – and technical universities in particular – as well as in management positions in the industry. The aim of the studies comprises an introduction of candidate to the newest scientific achievements and research results in the area chosen as the subject of her/his PhD thesis. Currently, there is a substantial demand for such graduates, well prepared for teaching and conducting research at technical universities. At these universities, a "generation gap" is observed among their employees and the graduate school should fill that gap.

Within the frames of the PhD level graduate school, candidates acquire specialized knowledge in the field of Materials Engineering, broaden their cognitive capabilities and collect experiences necessary in research work. Simultaneously, they acquire teaching and organizational experiences and develop scientific contacts through participation in seminars and conferences, both domestic and external.

After finishing the training and a completion of the PhD thesis, a candidate is equipped with a broadly specialized knowledge, an ability to perform scientific collaboration with domestic laboratories, university teaching experience and analytical abilities necessary in research work. Those candidates who do not plan scientific career shall utilize their cognitive abilities as well as teaching and organizational experiences, gained in the frames of the graduate school, in the course of their further professional employment.

3. Detailed entry requirements

Persons applying for an admission to the IDS in the area of Materials Engineering must possess MS qualifications acquired in one of the following areas: materials engineering, mechanical engineering, chemistry, biology, physics, mechanics and machinery construction, physics and chemistry of textile science and design as well as biology. In particular cases candidates possessing MS qualifications in the area of medical sciences may also apply for admission.

4. Teaching methods

Lectures, exercises, laboratories, projects, scientific seminaries, distance education.

5. Graduate's profile

A Materials Engineering IDS graduate knows and understands the world's scientific and creative achievements in the field of Materials Engineering and the resulting practical implications in materials engineering applications. One is able to undertake an analysis and a creative synthesis of scientific achievements in order to identify and solve research problems as well as those related to innovative and creative activity. One is able to enrich the mentioned achievements, plan personal development and inspire others to do so, exchange experience and ideas within polish and international environment and what is more is ready to make an

independent research in order to expand scientific and creative achievements, face the professional and public challenges taking into account ethics and responsibility for its results and also to form a way of a proper behavior.

A strategic aim of the teaching programme is to prepare highly qualified personnel for scientific and innovative industry needs to work in advisory and project units, trading companies of engineering materials and its research equipment and also in laboratories related to quality control and certification of engineering materials. It is possible thanks to innovative and interdisciplinary scientific research and their application in a personnel preparation programme in compliance with “knowledge-based community” model. In particular, the aim of the training programme is to prepare a specialist who knows and understands the achievements of his field of interest at the level which allows him to revise current paradigms, but also understands the fundamental dilemmas of the present civilization; economical, juridical and other important in the field of research activity. Besides, the aim is to prepare a graduate student to use his broad knowledge to identify, formulate and solve complex problems or execute research tasks. Likewise, the aim is to create an awareness of the need of disseminating research results, initiating debates, participating in science discourses, using foreign language at the level allowing to take part in an international scientific and professional environment, as well as planning and pursuing an individual and group research or creative undertakes, also in an international environment.

Graduate understands a need of developing his qualifications by taking part in trainings, courses and also doing own scientific research preserving all ethical standards and is ready to solve problems related to Materials Engineering, knowing the present state of art.

6. Training plan

First year (Semester 1 and 2)		
No	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	World trends in Materials Engineering
3	CC2	Research Methods of Materials Science
4	CC3	Surface Engineering
5	CC4	Construction materials I
6	CC5	Construction materials II
Second year (Semester 3 and 4)		
No	Subcategory	Subject
1	CC6	Composite technologies
2	CC7	Numerical Analysis for Engineering
3	CC8	Strength of Materials

TRAINING PROGRAM IN DISCIPLINE:
Mechanical Engineering

1. Basic information

Domain: Engineering and Technology
Discipline: Mechanical Engineering
Degree awarded: PhD in Mechanical Engineering

2. Training demand

The doctoral training in the discipline of mechanical engineering prepares a highly qualified specialist to work in industry, research units, R&D units and at technological universities. The educational aim of this programme is to introduce gradually the applicant into research works. Within the doctoral school, candidates broaden considerably their general and specialist knowledge, which allows them to conduct individually investigations as well as research and engineering projects in the field of mechanical engineering. Doctoral candidates gather also didactic and organizational experience, establish scientific contacts through participation in trainings, lectures, conferences and seminars. With the extended scope of knowledge and skills gained, doctoral candidates are able to carry out research activities and projects and to implement novel solutions into industrial practice.

3. Detailed entry requirements

According to the legal regulations in force, the formal requirement to be fulfilled by a candidate is to be a graduate of the second cycle studies and to have a scientific title of Master of Science or to be a beneficiary of the Diamond Grant within the Ministry for Science and Higher Education programme. It is preferable to be a graduate of a technological university in widely understood mechanical engineering, which, however, does not exclude graduates of programmes of study related to mathematics, applied physics or information technology at technological universities or universities. A candidate should demonstrate a capability of individual work, acquisition and application of knowledge from various disciplines, and show predispositions for objective analysis and evaluation of the collected observations and results of investigations.

4. Teaching methods

Research trainings, lectures, tutorials, lab classes, projects, scientific seminars

5. Graduate's profile

Graduate in Mechanical Engineering demonstrates extensive knowledge in fundamental and applied sciences related to mechanical engineering and acquired skills allowing for solving interdisciplinary problems. One is prepared to implement modern methods, technical solutions and technologies while designing mechanical systems. The graduate is able to use advanced analytical, computational and experimental techniques in the field of mechanical engineering. He/she is prepared to participate in computer-aided projects. Graduates are capable of acquiring and widening their knowledge on the basis of literature in the range required during work and can analyze critically the solutions proposed, indicate crucial limitations of the issues being solved and solve creatively the problems involved. The graduate can apply the knowledge acquired to solve selected scientific and technical problems, plan and analyze the results of experimental investigations. The extended scope of knowledge and the skills acquired enable him/her to conduct research and project activities

and implement novel solutions into industrial applications. On graduating from the doctoral school and having written a PhD dissertation, the candidate demonstrates broad specialist knowledge, an ability to participate in scientific cooperation with other centers in Poland and abroad. The graduate attends a series of trainings and participates in workshops devoted to self-presentation techniques, application for research grants, management and communication in a team, application of IT tools, patenting and implementation procedures. The graduate shows research skills indispensable in further scientific work as well as research and implementation activities. The potential labor market for the graduate covers technological universities, companies active in the field of construction and technology of machine building, designing, industrial technologies, as well as R&D departments and design offices in manufacturing companies. The technical solutions graduates arrive at individually can be employed in their own innovation and implementation start-ups or technical support companies.

6. Training plan

First year (Semester 1 and 2)		
No	Subcategory	Subject
1	E	Entrepreneurship
1	CC1	Mathematical Methods of Mechanics
2	CC2	Numerical Methods in Mechanics
3	CC3	Advanced Manufacturing
4	CC4	Mechanics of Solids and Structures
5	CC5	Metrology and Control in Mechanical Engineering
6	CC6	Fluid Mechanics

TRAINING PROGRAM IN DISCIPLINE:
Automation, Electronic and Electrical Engineering

1. Basic information

Domain: Engineering and Technology
Discipline: Automation, Electronic and Electrical Engineering
Degree awarded: PhD in Automation, Electronic and Electrical Engineering

2. Training demand

The development of knowledge-based economy in the field of new technologies such as automation, electronic and electrical engineering raises the demand for high-class specialists, including Ph.D. in engineering and technical sciences, employed in higher education institutions, research and development departments, manager consulting firms, as well as in small and medium-sized enterprises. Graduates are expected to have broadened and theoretically grounded basic knowledge in disciplines related to the area of research, to be familiar with new trends, and to be able to think in a creative, innovative way. The abilities to supervise a team, to establish priorities and manage competing deadlines for themselves and others are also important.

3. Detailed entry requirements

Doctoral candidates may qualify for admission if they have a master's degree in science or engineering, in particular in the following fields: electrical, electronic, computer, and automation engineering. Candidates should demonstrate the ability to present and defend their research plans, to evaluate and comment on the work of others, to participate in discussions on technical and scientific issues, to organize their self-education, and to conduct self-directed research. They should be able to acquire and apply the knowledge of other disciplines.

4. Teaching methods

Lectures, classes, laboratories, projects, seminars.

5. Graduate’s profile

A graduate has a detailed knowledge corresponding to their own area of scientific research in automation, electronic and electrical engineering. A young scientist is prepared to manage their own research team. They are able to work on R&D managerial position, create new structures and independent businesses such as Spin off/out or Start up. A graduate has the ability to modify, evaluate and consult new solutions in terms of their efficiency, profitability and innovation. They are able to review scientific publications, draw conclusions, present and defend their own opinions. They have acquired basic teaching skills. A graduate pursues research ethos that promotes exceptional expertise as well as ethical responsibility in the quest for knowledge and the development, conservation and transfer of such knowledge. They are aware of their professional responsibilities to society and to the specific communities in which they work.

PhD in automation, electronic and electrical engineering is highly employable and can find work in many areas, including research and development departments, universities, and the sector of small and medium-sized enterprises. Thanks to a comprehensive education a graduate can be a leader of design and creative teams. They can work in consulting companies, and in the state/local government sector (public sector agencies, local government).

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Scientific Research Methodology in Automation, electronic and electrical engineering
3	CC2	Signals and systems
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC3	Modeling of Dynamical Systems – part 1
2	CC4	Statistics for Automation, electronic and electrical engineering - part 1
3	CC5	Modeling of Dynamical Systems - part 2
4	CC6	Statistics for Automation, electronic and electrical engineering - part 2
MEDIUM-TERM ASSESSMENT		
Third year (Semester 5 and 6)		
No.	Subcategory	Subject
1	CC7	Modern numerical methods in optimization – part 1
2	CC8	Modern numerical methods in optimization – part 2

TRAINING PROGRAM IN DISCIPLINE: Information and Communication Technology

1. Basic information

Domain: Engineering and Technology
Discipline: Information and Communication Technology
Degree awarded: PhD in Information and Communication Technology

2. Training demand

Development of a knowledge-based economy in new technologies in the discipline of information and communication technology raises the demand for high-class specialists, including degree of doctor of technical sciences, employed in scientific institutions, research and development units, consulting and advisory boards, as well as in the small and medium sector companies. Doctoral studies prepare the most talented candidates to write and defend dissertations.

3. Detailed entry requirements

Completing the Master's Degree in technical sciences or exact sciences, in particular in the following fields of study: electrical engineering, electronics and telecommunications, automation and robotics, computer science or applied mathematics. Candidate should show the ability to self-education, organization of his or her own work, presentation, discussion and communication skills.

4. Teaching methods

Lectures, individual and group projects, laboratory sessions, seminars.

5. Graduate's profile

Person who obtained the degree of doctor in discipline Information and communication technology.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Research methodology
3	CC2	Statistics
4	CC3	Advanced data processing algorithms and structures
5	CC4	Advanced human-computer interaction methods
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC5	Computational intelligence 1
2	CC6	General-purpose computing on graphics processing units
3	CC7	Computational intelligence 2

TRAINING PROGRAM IN DISCIPLINE:
Civil engineering and Transport

1. Basic information

Domain: Engineering and Technology
Discipline: Civil Engineering and Transport
Degree awarded: PhD in Civil Engineering and Transport

2. Training demand

The knowledge-based society requires highly skilled workers in various branches of industry related to material engineering, construction design, building maintenance, sustainable development, high schools ranking among the top ones, higher education and research and development centres. According to thorough investigations civil and transport engineers are commonly those with least unemployment rate among engineers from various technical disciplines. This is a consequence of both theoretical and practical training which is implemented, and which is based on utmost scrutiny and high level analysis. Moreover, the research skills, trained in civil engineering and transport courses, lead to the habit of checking all details and foreseeing possible opportunities which is believed to be indispensable in a modern economy, which is based on innovation. With such a profile of research and related skills PhD in civil engineering and transport are valued as possible employees in areas that require comprehensive analytical skills. Last but not least there is some demand of employing new instructors and assistant professors at universities and colleges in Poland due to the fact of increasing generation gap that has been observed. Moreover, graduates with attitude towards interdisciplinary research will bring some new ideas and possible influence future research directions.

3. Detailed entry requirements

For PhD in civil engineering and transport there are eligible graduates of civil engineering, mechanics, materials engineering or other related courses. The candidates are advised to get in touch with possible future supervisor and tutors and start cooperation prior to the admission procedure. Future candidates are advised to investigate topics related to seminars held in the discipline of civil engineering and transport at the Lodz University of Technology as well as the formal and informal research requirements demanded by research groups. The choice of preferable research group prior to entrance examination is warmly advised since not all existing branches of civil engineering are present at LUT.

4. Teaching methods

Teaching methods vary from course to course reflecting the teaching attitude towards civil engineering and transport. These comprise, laboratory applying the up-to-date measuring techniques, presentations with details being presented on the board, seminars, projects and case study problem solving using modern software, development of numerical codes for solving various non-linear problems but also traditional board and chalk lectures are given. Very often a sort of mixed methods is employed. There are offered courses allowing for broadening of knowledge and developing skills from various fields of engineering: mechanics, materials engineering, materials chemistry, steel and concrete reinforced structures, etc. Level of the courses is based on the profile of candidates and so are the methods which would be chosen through the course.

5. Graduate’s profile

PhD graduate in civil engineering and transport knows and understands the worldwide scientific knowledge related to the area of PhD thesis and their implications for practical applications, especially in the other branches of engineering. The graduate can perform through analysis and synthesis of scientific results in order to identify and solve research task with introduction of innovative solutions and observations. PhD graduate is equipped with the broad knowledge in the field of civil engineering and transport concerning in particular the mechanics of microstructural materials, the multiphysics problems, thermo-mechanics, etc. One is able to recognize and analyse the problems, select and efficiently use the appropriate scientific tools. The graduate can plan her/his development and inspire others to participate in discussions, solving problems, also in international environment. The graduate is ready to start independent scientific research, undertake challenges both in science and society, putting emphasis on ethical aspects and social impact of undertaken tasks.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Physics of Building Materials I
3	CC2	Physics of Building Materials II
4	CC3	Reliability and Optimization in Civil Engineering I
5	CC4	Reliability and Optimization in Civil Engineering II
6	CC5	Advanced mechanics of soils I
7	CC6	Advanced mechanics of soils II
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC7	Computational methods in non-linear solid mechanics I
2	CC8	Computational methods in non-linear solid mechanics II

TRAINING PROGRAM IN DISCIPLINE:
Architecture and Urban Planning

1. Basic information

Domain: Engineering and Technology
Discipline: Architecture and Urban Planning
Degree awarded: PhD in Architecture and Urban Planning

2. Training demand

The Institute of Architecture and Urban Planning, TUL is one of the main centers in the central part of Poland educating doctors of technical sciences in the discipline of urban planning and architecture. The doctoral school prepares for work in research units, research and development units, in universities - especially technical ones through the gradual introduction of a candidate for research work using the latest achievements and scientific results in the field of doctoral studies selected by the candidate. A graduate after obtaining a doctorate not only has extensive knowledge in the field of urban planning and architecture, but also has the ability to set, analyse and propose solutions to problems and their synthetic description. These features allow to flexibly adapt to work also in areas that go beyond the disciplines of architecture and urban planning.

3. Detailed entry requirements

The formal requirement for candidates are the completion of the master's studies in the field of architecture or another with a similar scope. In addition, the candidate should demonstrate the ability to work independently, the ability to acquire and apply knowledge from various fields, as well as demonstrate predispositions for objective analysis and evaluation of the collected observations and research results.

4. Teaching methods

Lectures, classes, laboratories, projects, scientific seminars, distance learning.

5. Graduate’s profile

The graduate of the IDS TUL is a fully-fledged researcher, freely using the current state of scientific knowledge in the discipline of architecture and urban planning. Developing his career, he improves practical and theoretical skills of an interdisciplinary character. During training, one acquires knowledge related to the most advanced technologies, trends and development trends under the supervision of lecturers from domestic and foreign centres, which can be used in individual research. The IDS prepares young scientists for both own research and cooperation within research teams, implementation of new techniques and technologies used in the discipline of architecture and urban planning - as well as creating independent entities such as Spin-off /out or Start-ups. In addition, graduates gain knowledge needed to work in organizations related to local and government administration, cultural institutions and activities in the area of creative industries.

Graduates can also modify, give opinions and consult new solutions within architecture and urban planning in terms of their efficiency, profitability and innovation - also in the wider context of sustainable development and can find employment in all industries related to architecture, urban planning, design and broadly defined culture. Doctoral holders in technical sciences are not only talented scientists, but also represent the most valuable and creative background - as the middle and senior management in the creative industries and business.

The research group gives the opportunity to create innovative technologies and solutions in leading research and development centres in the field of architecture and urban planning.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Conducting research in the field of architecture and urban planning I
3	CC2	Conducting research in the field of architecture and urban planning II
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC3	Conducting research in the field of architecture and urban planning III
2	CC4	Conducting research in the field of architecture and urban planning IV

TRAINING PROGRAM IN DISCIPLINE: Chemical Engineering

1. Basic information

Domain: Engineering and Technology
Discipline: Chemical Engineering
Degree awarded: PhD in Chemical Engineering

2. Training demand

The current demand for highly qualified engineering staff is very high and comes from the needs of higher education and research institutes, both in Poland and abroad. Our own analysis shows that doctoral candidates often receive their job offers even during their studies. Some of them are sent to study by their employers. Rapid development of economy, science and industry, allows for the assumption that this trend will continue in the coming years.

3. Detailed entry requirements

The formal requirement for candidates is the graduation from MSc course in chemical engineering or other technical course of a similar scope. In addition, the candidate should demonstrate the ability to work on their own, the ability to acquire and apply knowledge from various fields, as well as demonstrate predispositions for the objective analysis and evaluation of the collected observations and experimental results.

4. Teaching methods

Lectures, tutorials, laboratories, projects, seminars, e-learning.

5. Graduate's profile

The graduates of the IDS TUL in the discipline chemical engineering are fully skilled persons in terms of the scientific knowledge in chemical and process engineering. By developing their scientific and professional career they improve the practical applications of this area of knowledge, also taking the environmental problems into account, developing and designing research and industrial installations. In the course of training they gain the knowledge related to the most advanced technologies and development trends under the supervision of lecturers from Polish and foreign scientific centers and ultimately doctoral candidates are directed to thoroughly study the issues related to their individual doctoral theses. Advanced design and laboratory work prepare these young scientists for the tasks related to the creation of their own research teams, managing R&D departments in enterprises, creating the consortia for developing new technologies, development of products, processes and services as well as creating the independent entities like Spin off/out or Start-ups. In addition, they gain knowledge required to work in the institutions related to the technical and process safety. They can also modify, evaluate and consult new technological and product solutions in terms of their efficiency, profitability and innovativeness, also in the wider context of a sustainable and low-carbon circular economy.

For the specialists in this area all industries and institutions associated with advanced chemical engineering are open. These are processing, chemical, pharmaceutical and food industries, energy production, renewable energy sources sector. Referring to the experience of economies of innovation leaders, we are fully convinced that people with a PhD degree in chemical engineering are not only talented scientists but they also represent the most valuable and creative background - as the middle and senior management in the industry and business. They also create breakthrough technologies and solutions in the leading research and development centers. The

important sectors of the employment for our graduates are also state and local government administration institutions as well as NGOs. They seek our graduates as their expert, consultative and supervisory employees to ensure environmental safety, safety of production processes and products.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Transport phenomena
3	CC2	Green chemistry and engineering

TRAINING PROGRAM IN DISCIPLINE:
Chemical Sciences

1. Basic information

Domain: Natural Sciences
Discipline: Chemical Sciences
Degree awarded: PhD in Chemical Sciences

2. Training demand

The Faculty of Chemistry of the Lodz University of Technology is the only one in the central part of Poland to educate doctors of science and natural sciences in the discipline of chemical science, in 1. chemistry or 2. chemical technology, having engineering background. The studies shall prepare the candidate for work in research units, research and development units, universities - especially technical universities - by gradually introducing the candidate to research work using the latest achievements and results of scientific work in the field of doctoral studies chosen by the candidate. After obtaining doctorate, the graduates have not only extensive knowledge of chemistry and chemical technology, but also the ability to pose, analyze and propose solutions to problems and their synthetic description. These features allow them to adapt flexibly to work in areas not only related to chemistry.

3. Detailed entry requirements

Graduates from master courses of the following faculties are accepted for studies: chemistry, chemical technology, chemical engineering, material engineering, physics and related fields (e. g. biochemistry, biophysics), not necessarily completed at polytechnic faculties. In addition, the candidate should demonstrate the ability to work independently, to acquire and apply knowledge in a variety of fields, and to demonstrate aptitude for objective analysis and evaluation of the observations made and collected results of the tests.

4. Teaching methods

Lectures, tutorials, laboratories, projects, seminars, e-learning

5. Graduate’s profile

The training prepares graduates to work in research and development units and universities, especially technical universities. The graduate has extensive and in-depth knowledge of concepts, principles and theories in the field of chemistry and chemical technology, with particular emphasis on the areas related to the prepared thesis, which was gained under the supervision of lecturers, including those from renowned foreign centres. The graduate is prepared to work with the use of modern research techniques, knows the mechanisms for raising funds for scientific research and implementation work from both domestic and international sources, and is prepared to work independently or in a group - including international ones. Advanced design and laboratory works prepare young scientists for tasks related to creating their own research teams, managing R&D departments in enterprises, creating consortia developing new technologies, developing products, processes and services - as well as creating independent entities such as Spin off/out or Start-ups. They can also modify, assess and consult on new technological and product developments in terms of their efficiency, cost-effectiveness and innovativeness - including in the broader context of a sustainable and low-carbon circular economy. Graduates are able to conduct didactic classes at the first and second level of studies, they are also able to conduct

scientific research in accordance with the rules of ethics in science and technology. Graduates understand the need for continuous learning and maintaining the ethos of research community.

The specialists in these areas are also awaited by industries and institutions related to advanced materials, technology of production and processing. It is primarily the chemical industry in its broadest sense, but also, among others, the agro-food industry, pharmaceuticals, construction chemicals, transport and automotive industry. Based on the experience of innovation leader economies, it can be said with confidence that doctorate holders in chemical sciences are not only talented scientists, but also the most valuable and creative individuals - as middle and senior management both in industry and business. This group also creates breakthrough material solutions and technologies in leading research and development centres. An important sector of employment are also institutions of state and local government administration as well as NGOs, seeking these graduates for their tasks of expert, opinion-forming, supervisory, ensuring the safety of the environment, production processes, work, products, etc.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Advanced Inorganic Chemistry
3	CC2	Advanced Organic Chemistry
4	CC3	Advanced Physical Chemistry
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC4	Advanced Molecular and Macromolecular Science

TRAINING PROGRAM IN DISCIPLINE: Mathematics

1. Basic information

Domain: Natural Sciences
Discipline: Mathematics
Degree awarded: PhD in Mathematics

2. Training demand

The knowledge-based society requires highly skilled experts in various branches of industry, banking system, high schools ranking among the top ones, higher education and research and development units. According to the through investigations mathematicians are commonly those with least unemployment rate with lowest unemployment rate for the PhDs. This is a consequence of training which is being implemented and which is based on utmost scrutiny and a high-level analysis. Moreover, the mathematical research skills lead to the habit of checking all details and foreseeing possible opportunities which is believed to be indispensable in a modern society. With such a profile of research and related skills PhD in mathematics are especially valued as possible employees in areas that require sophisticated analytical skills not to be learned through traditional courses. Last but not least there is some demand of employing new instructors and assistant professors at universities and colleges in Poland due to the fact of increasing generation gap that has been observed. Moreover, graduates with attitude towards interdisciplinary research will bring some new ideas and possible influence future research directions.

3. Detailed entry requirements

Mathematics graduates are eligible for doctoral training in mathematics. The candidates are advised to get in touch with possible future supervisors and start cooperation prior to the examination procedure. Future candidates are advised to investigate topics related to seminars held in the discipline of mathematics and at Lodz University of Technology as well as the formal and informal research requirements demanded by research groups. The choice of preferable research group prior to entrance examination is warmly advised since not all existing main branches of mathematics are present at LUT.

The enrolment exam includes a discussion on mathematical interests of candidates pertaining to:

A) their MSc. thesis whose main ideas are to be presented;
B) scientific achievements obtained so far- if any;
C) classical oral exam covering the following topics (questions are formulated by the commission during discussion):
    1. Mathematical analysis (continuity, differentiability and integrability of functions of one and several variables - basic notions, theorems and relations).
    2. Examples of Banach spaces (space of continuous functions, spaces of integrable functions with power greater or equal to 1 - their properties).
    3. Fundamental theorems in functional analysis (Hahn-Banach, Banach-Steinhaus, open mapping, closed graph, Banach-Alaouglu) with necessary background information.
    4. Fundamentals in topology (continuity, compactness, connectedness, homeomorphisms).
    5. Lebesgue measure and integration (construction, integrability, modes of convergence, comparison with the Riemann Integral).
    6. Basics of probability theory.
    7. Linear algebra (Jordan matrices, eigenvalues, linear mappings)

4. Teaching methods

Teaching methods vary from course to course reflecting the teaching attitude towards mathematics. These comprise traditional board and chalk lectures, presentations with details being presented on the board, seminars, projects and case study problem solving tutorials. Very often a sort of mixed method is employed. There are offered courses allowing for broadening of mathematical knowledge and developing mathematical skills. Level of the courses is based on the profile of candidates and so are the methods which would be chosen through the course.

5. Graduate's profile

Doctorate holder in mathematics knows and understands the worldwide scientific knowledge related to the area of PhD thesis and their implications for practical applications, especially in the field of engineering. The graduate can perform thorough analysis and synthesis of scientific results in order to identify and solve research task with introduction of innovative solutions and observations. The graduate can plan development and inspire others to participate in discussions, problem solving, also in an international environment. The graduate is ready to start independent scientific research, undertake challenges both in science and society, putting emphasis on ethical aspects and social impact of undertaken tasks.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Modern Mathematical Analysis 1
3	CC2	Modern Mathematical Analysis 2
4	CC3	Stochastic Processes I
5	CC4	Stochastic Processes 2
6	CC5	Applied Functional Analysis 1
7	CC6	Applied Functional Analysis 2
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC7	Mathematical Methods in Life Sciences and Engineering 1
2	CC8	Mathematical Methods in Life Sciences and Engineering 2

TRAINING PROGRAM IN DISCIPLINE:
Physical Sciences

1. Basic information

Domain: Natural Sciences
Discipline: Physical Sciences
Degree awarded: PhD in Physical Sciences

2. Training demand

The PhD training program in physics prepares the PhD candidates for work in research units, research and development units, universities - especially technical universities. The aim of the training program is to gradually introduce a candidate to research work and expose her/him to the latest achievements and scientific results in the discipline of physics. In science faculties of both technical universities and universities, there is a "generation gap" among those conducting research. There is a need for staff trained to conduct research and didactic work at faculties of exact sciences.

3. Detailed entry requirements

Completing the Master's Degree, or equivalent, in physics, chemistry or other disciplines of science, allowing a candidate to undertake a PhD program in physics.

4. Teaching methods

Lectures, tutorials, laboratory, seminars, participation in workshops, conferences. Collaborative work in research groups.

5. Graduate’s profile

After completing a program in physics and obtaining a PhD degree a graduate not only has an extensive knowledge in this discipline, but also has the ability to set, analyze and propose solutions to problems and their synthetic description. A graduate is capable of establishing collaborations and conducting team research projects.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Current trends in physical sciences 1
3	CC5	Advanced research planning and management in physical sciences 1
4	CC2	Current trends in physical sciences 2
5	CC6	Advanced research planning and management in physical sciences 2
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC3	Current trends in physical sciences 3
2	CC7	Advanced research planning and management in physical sciences 3
3	CC4	Current trends in physical sciences 4
4	CC8	Advanced research planning and management in physical sciences 4

TRAINING PROGRAM IN DISCIPLINE:
Nutrition and Food Technology

1. Basic information

Domain: Agricultural Sciences
Discipline: Nutrition and Food Technology
Degree awarded: PhD in Nutrition and Food Technology

2. Training demand

The doctoral training in nutrition and food technology at Lodz University of Technology has a mission to multiply and disseminate knowledge, aiming at educating highly qualified staff for the needs of the economy and administration. The primary goal is to educate graduates with interdisciplinary knowledge who can use it in both research and practice. Another goal is to teach graduates the ability to present and publish results of their research and to defend their research theories. Graduates after obtaining the doctoral degree in agricultural sciences in the discipline of food and nutrition technology, due to the interdisciplinary nature and multi-directional education program have extensive knowledge related not only to the basic discipline, but also broadly understood biotechnology and chemical engineering.

3. Detailed entry requirements

A formal requirement for candidates is the completion of master's studies in nutrition and food technology or chemical engineering or other related fields. In addition, candidates should demonstrate the ability to work independently, the ability to acquire and apply knowledge in various fields, as well as demonstrate predispositions for objective analysis and evaluation of collected observations and research results.

4. Teaching methods

Lectures, classes, laboratories, projects, scientific seminars

5. Graduate’s profile

Graduates know and understand scientific world and creative achievements and practical implications resulting from them. They are able to analyze and creatively synthesize scientific and creative achievements in order to identify and solve research problems and issues related to innovative and creative activities as well as to contribute to these achievements. Graduates can consciously and independently plan their development and inspire the development of other people and participate in the exchange of experiences and ideas in the national and international environment. They are ready to undertake independent studies enlarging the existing scientific and creative achievements, taking up challenges in the professional and public sphere, taking into account their ethical dimension and responsibility for their effects and shaping patterns of proper behavior in such situations. Graduates will find employment at domestic and foreign universities as well as in research and development centers as researchers and scientists. They will be highly qualified staff of modern enterprises that implement production processes using waste-free innovative technologies in areas such as biotechnology, agriculture and food, cosmetics and pharmaceutical industries. They can also modify, evaluate and consult new technological and product solutions in terms of their efficiency, profitability and innovativeness – also in the wider context of a sustainable and low-carbon circular economy.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Modern trends in food technology I
3	CC2	Phytocompounds as bioactive food ingredients
4	CC3	The role of phytocomponents in the prevention of civilization diseases
5	CC4	Advances in fermented food and beverages I
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC5	Modern trends in food technology II
2	CC6	Biocatalysis
3	CC7	Modern microbiological analysis in food industry
4	CC8	Advances in fermented food and beverages II

TRAINING PROGRAM IN DISCIPLINE: Management and Quality Studies

1. Basic information

Domain: Social sciences
Discipline: Management and quality studies
Degree awarded: PhD in Management and quality studies

2. Training demand

The systemic changes occurring in the Polish and global economy, such as the inflow of foreign capital, the emergence of a large, small and medium enterprises, the development of new management concepts, growing environmental requirements, growing level of education as well as the aspirations of society, require the education of scientists comprehensively prepared to undertake international research in the discipline of management and quality sciences, as well as organizational and managerial functions at various levels of enterprises. Therefore, there is a need for education in the field of management, preparing for work in research and development units, in higher education institutions through the introduction of a candidate for research work using the latest achievements and scientific results in the field of doctoral studies selected by the candidate. A graduate, having obtained a doctorate, has not only extensive knowledge in the field of management and quality studies, but also has the ability to set, analyze and propose solutions to complex problems and their synthetic description. These features allow him to flexibly adapt to taking up employments in various fields.

3. Detailed entry requirements

The formal requirement for candidates for studies is to have the master's diploma or an equivalent diploma. In addition, the candidate should demonstrate the predisposition to scientific and research work, the ability to work independently, the ability to acquire and apply knowledge from various fields, as well as the predispositions for objective analysis and evaluation of the own observations and collected research results.

4. Teaching methods

Lectures, tutorials, laboratories, projects, scientific seminars.

5. Graduate’s profile

The graduate of IDS TUL in the discipline of management and quality studies is a person fully skilled in terms of the state of scientific knowledge in the area of organization and management. Developing one’s scientific and professional career – is able to improve the research and practical application of these areas of knowledge with particular emphasis on the problems of managing all the basic areas of the modern enterprise. In the course of studies, the graduate gains knowledge related to the most advanced methods, techniques, trends and tendencies under the supervision of lecturers from local and foreign centers. The graduates are directed to issues related to individual subject of the doctoral theses. Realization of the research projects prepares young scientists for tasks related to creating their own research teams, managing R&D departments in enterprises, creating international consortia, development of products, processes and services, as well as creating independent entities such as spin off or start up. In addition, they gain the knowledge needed to take up

managerial functions at all levels within the company regardless of its size and character, both in large enterprises and the SME sector.

The graduate is able to actively use of knowledge acquired during studies and apply it in research area, as well as in a business practice, to make critical analysis and evaluation of phenomena of the modern management, diagnoses and assesses managerial problems using a clear and precise specialist language.

6. Training plan

First year (Semester 1 and 2)		
No.	Subcategory	Subject
1	E	Entrepreneurship
2	CC1	Management concepts - in theory
3	CC2	Economics 1
4	CC3	Management concepts - in practice
5	CC4	Economics 2
Second year (Semester 3 and 4)		
No.	Subcategory	Subject
1	CC5	Research methodology in management and quality sciences 1
2	CC6	Quantitative methods in social sciences 1
3	CC7	Research methodology in management and quality sciences 2
4	CC8	Quantitative methods in social sciences 2