Project Nr. 8.2.1.0/18/A/016 "The reduction of fragmentation of the study programmes and strengthening the sharing of the resources in the study directions "Management, administration and real estate management" and "Mechanics and metalworking, heat power industry, heat engineering and mechanical engineering" at Rezekne Academy of Technologies"

Doktora studiju programmas "Lāzertehnoloģijas" pilna laika studiju plānojums
Doctoral study program "Laser Tehnologies" full time planning

Kursa / moduļa nosaukums *Name of the course / module* LAT/ENG	Atbildīgā mācībspēka vārds, uzvārds Responsible academic staff's name, surname	KP	Plānojums/ *Planning*					
			1.k.		2.k.		3.k.	
			Studiju semestris/ *Study semester*					
			1	2	3	4	5	6
		30	13	8	5	4	-	-
Transversālo prasmju attīstība/ Development of transversal skills								
Zinātnisko pētījumu metodoloģija/*Scientific research methodology*	PhD R. Minev, RU	**3**	3					
Zinātniskā rakstība un komunikācija, intelektuālais īpašums / *Scientific writing and communication, intellectual property*	PhD R. Minev, RU Dr.sc.soc. S.Murinska, RTA Dr.sc.ing. E.Teirumnieks, RTA	**3**	3					
Nozares teorētiskie kursi/ Theoretical courses in the field								
Lāzersistēmas/*Laser systems*	PhD Ivaylo Balchev, RTA	**4**		4				
Lāzermakrotehnoloģijas/ *Laser Macro-technology*	Dr.sc.ing.Lyubomir Lazov, RTA Dr.sc.ing.A.Skromulis, RTA	**4**	4					
Nozares pamatkursi/ Basic courses in the field								
Lāzersistēmas aditīvajā ražošanā un MNTs/*Laser Assisted Additive Manufacturing and MNTs*	PhD Rusi Minev, RU	**4**		4				
Lāzerdrošība un medicīnas tehnoloģijas/*Laser Safety and Medical Technology*	PhD Tsanko Karadjov, RU	**3**			3			
Modelēšana un simulācijas lāzertehnoloģijās /*Modeling and simulations of laser technologies*	Dr.sc.ing. Nikolay Petrov, RU	**3**	3					
Lāzertehnoloģijas drošības un aizsardzības	Dr.sc.ing.Edmunds Teirumnieks, RTA	**2**			2			

jomā/*Laser Technologies for Security and Defense*								
Specializētie IT kursi nozarē/ Specialized IT courses in the industry								
Sensoru tīkli un sensoru datu apstrāde/ *Sensor networks and sensor data processing*	Dr.sc.ing.A.Teilāns, RTA	**2**				4		
Industrijas diskrētu notikumu simulācija/ *Industry discrete event simulation*	Dr.sc.ing.A.Teilāns, RTA	**2**						
LIDAR datu apstrāde/*LIDAR data processing*	Dr.sc.ing. S.Kodors, RTA	**2**						
Lielo datu apstrāde/ *Big data processing*	Dr.sc.ing. P.Grabusts, RTA	**2**						
Zinātniskais darbs/ *Scientific work*	Zinātniskie vadītāji/Scientific supervisors: – Dr.sc.ing. Ļubomirs Lazovs (Lyubomir Lazov) – PhD Rusi Minev – Dr.sc.ing. Edmunds Teirumnieks – PhD Ivaylo Balchev – Dr.sc.ing. Nikolay Angelov – Prof. Dr.sc.ing. Artis Teilāns – Assist. prof. Dr.sc.ing. Sergejs Kodors – Prof. Dr.sc.ing. Pēteris Grabusts	**90**	7	12	15	16	20	20
T.sk. Publikācijas, ziņojumi konferencēs/	Promocijas darba vadītājs/-i vai Kopīgā programmas padome/ *Doctoral Thesis*	**6**						

Publications, conference reports	*Supervisor (s) or Joint Program Council*							
***T.sk. Vasaras/ziemas skola, kolokvijs/** Summer / winter school, colloquium*	Promocijas darba vadītājs/-i vai Kopīgā programmas padome/ *Doctoral Thesis Supervisor (s) or Joint Program Council*	**4**						
***T.sk. Pedagoģiskā prakse/** Pedagogical practice (piemēram, bakalaura darbu/studiju darbu vadīšana, studiju kursu līdzvadīšana/asistēšana)*	Promocijas darba vadītājs/-i vai Kopīgā programmas padome, Fakultātes/ *Doctoral Thesis Supervisor (s) or Joint Program Council, Faculty*	**4**						
	Kopā: Total:	**120**	**20**	**20**	**20**	**20**	**20**	**20**

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Title of the course: Methodology of scientific researchRAIS
code: awarded by RAIS
Credit points: 3
ECTS credits: 4.5

Total hours: 120

Number of lectures: 20 (F); 10 (P)

Number of seminars, workshops: 10 (F); 5 (P)
Number of lectures for students' individual work: 90 (F); 105 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)
Course developer: scientific / academic degree, position, name, surname:

Assoc. prof. PhD Roussi Minev, RU

Requirements for the course: Experience in writing academic papers, e.g. article in a student scientific conference, experience in working with scientific databases. Basics in statistics.

Course abstract: the goal of course is to train PhD students to develop research plan: to design experiment and to analyze collected data, as well as, to control quality of experiment including vizualisation methods. The course is based on many disciplines: descriptive statistics, statistical analysis, probability theory, etc., which are applied in research work.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach to research.	- know research methods; - know data analysis tools and methods.	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations

Skills (ability to apply knowledge, communication, general skills): -Is able to plan and conduct research in laser technologies, prepare publications at an internationally cited level, patent applications and create innovations. -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice.	- can organize surveys; - is able to prepare scientific publications and presentations; - can analyse data.	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations

Competencies (analysis, synthesis and evaluation): Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information.	- are competent to plan experiments; - are competent to use data analysis tools; - is able to find and process information.	Workshops, Discussions	Workshops, Discussions

Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	Research design and their types.	2	1
2.	Sampling and its formation methods. Selection of research participants.	1	0.5
3.	Reliability and validity.	4	2
4.	Research ethics.	1	0.5
5.	Data collection methods and their specifics in communication research.	1	0.5
6.	Qualitative data collection methods.	1	0.5
7.	Qualitative data analysis methods.	8	4
8.	Quantitative data analysis methods.	12	6

Students' individual work

Form of individual work	**Hours**	
	Full time studies	**Part time studies**
Students' individual tasks	75	85
Preparation for seminars	15	20

Form of testing: exam

Requirements for final examination:

- participation in workshops and lectures – 40%;
- individual tasks completed – 20%;
- exam – 40 %.

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Literature:
ITextbooks (~3-4)

1. Glen Cowan. Statistical Data Analysis (Oxford Science Publications), 216 lpp., 2008.
2. Herman J. C. Berendsen. A Student's Guide to Data and Error Analysis, 238 lpp., 2011.
3. Patricia Leavy. Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches, 301 lpp., 2017.

II Additional literature (~5-6)

1. Wayne C. Booth. The Craft of Research, 336 lpp., 2016.
2. R. Lyman Ott and Micheal T. Longnecker. An Introduction to Statistical Methods and Data Analysis, 1296 lpp., 2015.
3. Peter Gedeck et al. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python, 368 lpp., 2020.
4. George E. P. Box et al. Statistics for Experimenters: Design, Innovation, and Discovery, 633 lpp., 2005.
5. Scott E. Maxwell et al. Designing Experiments and Analyzing Data: A Model Comparison Perspective, 1080 lpp., 2017.

III Internet resources (~2-3)

1. ekursi.rta.lv
2. docs.python.org/3/
3. www.r-project.org
4. www.ibm.com/analytics/spss-statistics-software

2.

Title of the course: Scientific writing and communication, intellectual property

RAIS code: awarded by RAISCredit points: 3

ECTS credits: 4.5

Total hours: 120

Number of lectures: 20 (F); 10 (P)

Number of seminars, workshops: 10 (F); 5 (P)

Number of lectures for students' individual work: 90 (F); 105 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:
Associate prof. PhD Roussi Minev, RU; Assist. prof. Dr.sc.comm. Sandra Murinska, RTA; Prof. Dr.sc.ing. Edmunds Teirumnieks, RTA

Requirements for the course: Experience in writing academic papers, e.g. article in a student scientific conference, experience in working with scientific databases.

Aim of the course: The aim of the course is to develop an understanding of the potentialof a young researcher and career opportunities in scientific institutions, higher education institutions and companies, as well as the improvement of research competencies and knowledge in intellectual property.

Course abstract: The communication skills of doctoral candidates will be improved by providing practical means of effectively demonstrating scientific results by promoting public interest in science and doctoral students' academic writing and communication skills are improved by providing the basic principles of writingscientific publications; improved ability to set goals, formulate tasks, hypotheses and conclusions, as well as provide practical techniques for effective presentation of scientificresults, promoting public interest in science. Understands the meaning and types of intellectual property, is able to search and write patent applications.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): Know and is able to reasonably choose modern research methods, adapt existing ones and develop	- understanding of the role and importance of science in society and industry; - awareness of the importance of scientific	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations

new ones based on an interdisciplinary approach to research.	culture and competence in society and in particular in promoting young people's interest in science; - understanding of future career opportunities in scientific institutions, higher education institutions and businesses; - understands the role and specifics of intellectual property in modern society and industry.		
Skills (ability to apply knowledge, communication, general skills): -Is ability to plan and conduct research in laser technologies, prepare publications at an internationally cited level, patent applications and create innovations. -Is ability to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice. - Is able to communicate both orally and in writing about field of scientific activity with the scientific community and society, providing a new understanding of it.	- educate public on topical issues in a simple, clear and comprehensible manner, explaining different problem situations - evaluate and compare examples of science communication in the world; - ability to write a report to one of the mass media about their research; - is able to search for patents, prepare a patent application, know the advantages and disadvantages of licensing agreements.	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations
Competencies (analysis, synthesis and evaluation): -Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. information, - Is able to constantly transfer new knowledge to students, demonstrate scientific and professional independence.	- evaluate and compare examples of science communication in the world; able to evaluate their effectiveness in society; - understanding ways and means of disseminating scientific results; - is able to critically evaluate the ways of intellectual property protection and develop a	Workshops, Discussions	Workshops, Discussions

	strategy for its maintenance.		

Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	**Scientific writing.** The standard structure of a scientific paper. Scientific language and style, storytelling in research. Figures and tables - graphical integrity. Citations and the literature search. Abstract and title. selection of a right journals, Editorial review process. Authorship and ethics of scientific research and publication. Research design and their types. Sampling and its formation methods. Selection of research participants. Reliability and validity, Research Process planning and organization. Data collection Methods and their specifics in communication research. Qualitative and quantitative data collection and analysis methods.	8	4
2.	Public understanding of scientific processes, developments and achievements. **Trends in science in Latvia and the world.** Links and relevance of science to other sectors and environments. Science and economics. Science and entrepreneurship. Science and innovation. Science and industry.	2	1
3.	**Research management, influence and impact.** Research strategy. Risk management. Scientific ethics and sutainability. Knowledge and intellectual abilities. Infrastructure and resources. Collaboration and work in the research group. Influence and leadershig, mentoring. Setting research targets. Open science and Open innovation, open science. Dissemination of knowledge through digital and collaborative technology.	2	1
4.	**Promoting international cooperation between scientists.** The growth opportunities of a scientist. Building a scientist's expertise. Opportunities for scientific funding in Latvia and the world. Networking, building partnerships for the realisation of competitive projects. Career opportunities. Post-doctoral opportunities. Improving research skills and raising qualifications. Creating a scientist profile on a career-4supporting site. Workshop.	4	2
5.	**Dissemination of scientific results** Exploring existing science communication resources. Latvian science communication practice. Basic principles of report making. Representation of scientific articles. Distribution. Representation of scientific articles. Possibilities and types of dissemination of scientific results. Public presentations at conferences, seminars. Preparing presentations. Pooling the study process and results. How to present the study briefly and interactively to the public. Various presentation formats – mass media, Researchers' Night, social campaigns, projects. Presentation of scientific results within 5 minutes. Workshop.	4	2

6.	**Intellectual property** History of intellectual property, types. Unregistered rights, registered rights. Protection of intellectual property.	3	1.5
7.	**Patents** Description of patents and inventions. Patentable and non-patentable objects. Patenting procedure in Europe and the world. Patent application and its components. Criteria for invention and patentability: novelty, level of invention, industrial use, feasibility. Patent search, bases. Exclusive rights of the patent owner. Sale of patents. Licensing, its advantages and disadvantages. License agreements. Workshop.	4	2
8.	**Other types of intellectual property** Copyright. Trademarks. Designs. Trade secret. Workshop.	3	1.5

Students' individual work

Form of individual work	**Hours**	
	Full time studies	**Part time studies**
Literature research and preparation for seminars	15	15
Opportunities for scientific funding in Latvia and the world; career opportunities after doctoral. Study of best practices in the world and in Latvia.	5	4
Develop an activity to present your research topic in an easy to understand, interesting and engaging way	15	15
Development of scientific article	30	31
During the patent search, a patent application has been developed in accordance with the potential topic of the dissertation.	25	25

Form of testing: exam

Requirements for final examination:

Participation in workshops and lectures – 40%
Development of scientific article – 60%

Literature:

I Textbooks (~3-4)

1. Chris Mack, (2018) How to write a good scientific paper, Published by SPIE, Washington
2. F.-N. Thomas and M. Turner, (1994) Clear and Simple as the Truth: Writing Classic Prose, Princeton University Press, Princeton, NJ
3. T. Chandrupatla, (2009) Quality and Reliability in Engineering, Cambridge University Press, pp. 88-232
4. Bilecen, B., C.Van Mol (2017) Introduction: International academic mobility and inequalities. *Journal of Ethnic and Migration Studies*, 43(8), 1241-1255
5. Burns, T., W., O'Connor, D. J., Stocklmayer, S. M. Science communication: a contemporary definition. *Public Understanding of Science*, 12, p.183–202.
6. Creswell J.W. (2003) Research Design: Qualitative, Quantitative and Mixed Methods Approaches. London, New Delhi: SAGE Publications
7. LU Diasporas un migrācijas pētījumu centrs (2017). *Diasporas zinātnieku piesaiste un sadarbības veicināšana*. Pētījuma rezultāti. Pieejams: https://www.diaspora.lu.lv/fileadmin/user_upload/lu_portal/projekti/diaspora/petijumi/Zinojums_zinatnieki_ar_kopsavilkumu.pdf

8. Mārtinsone, K., Pipere, A. (2018). *Zinātniskā rakstīšana un pētījumu rezultātu izplatīšana.* Rīga: RSU.
9. Mārtinsone, K., Pipere, A. (red.) (2011). Ievads pētniecībā: stratēģijas, dizaini, metodes. Rīga: RaKa
10. West, R., Turner, L. (2009). *Introducing Communication Theory: Analysis and Application*. McGraw-Hill Humanities.
11. Pasaules Intelektuālā īpašuma organizācija. PIĪO rokasgrāmata patentu rakstīšanā : rokasgrāmata / Pasaules Intelektuālā īpašuma organizācija (PIĪO); Latvijas Patentu valde. - Geneva, Switzerland : Pasaules Intelektuālā īpašuma organizācija, [2015]. - 137 lpp.
12. Intellectual property rights intensive industries : contribution to economic performance and employment in the European Union : industry-level analysis report, september 2013; a joint project between the European Patent Office and the Office for harmonization in the internal market / edit. by EPO and OHIM. - Munich, Germany : Office for Harmonization in the Internal Market, [2014]. - 143 p. : diagr. - (European Patent Office). - Bibliogr. : p.142.-143.

II Additional literature

1. European Commission (2018). Science, research and innovation performance of the EU. Strengthening the foundations for Europe's future. Pieejams: https://ec.europa.eu/info/sites/info/files/rec-17-015-srip-report2018_mep-web-20180228.pdf
2. Committee on Publication Ethics, (2011) version 4 "Code of Conduct and Best Practice Guidelines for Journal Editors"
3. C. A. Mack, (2015) "Editorial: 350 Years of Scientific Journals", J. Micro/Nanolith. MEMS MOEMS 14(1), p. 010101.
4. L. F. Azevedo et al. (2011) "How to write a scientific paper - Writing the methods section", Rev. Port. Pneumol. 17(5), pp. 232–238
5. Lasmane, S. (2012). *Komunikācijas ētika*. LU Akadēmiskais apgāds.
6. Vedins, I. (2008). *Zinātne un patiesība*. Rīga: Avots
7. Veinberga, S. (2019). *Komunikācija. Teorija un prakse*. Rīga: Sava grāmata.
8. Bently, Lionel, (1964-1964-).Intellectual property law / L. Bently ; B. Sherman. - 2nd ed. - Oxford : Oxford University Press ; New York, 2004. - 1131 p.
9. Vērtību mija : sarunas par tehnoloģiju licencēšanu ; mācību rokasgrāmata / tulk. no anglu val.; Pasaules Intelektuālā īpašuma organizācija; Starptautiskās tirdzniecības centrs. - Switzerland, Geneva : WIPO, 2008. - 178 lpp.
10. Wagner Michael H. Wegweiser fur den Erfinder / Michael H.Wagner und Wolfgang Thieler : von der Auflage uber die Idee zum Patent ; mit 122 Abbildungen. - 3., erweiterte und aktualisierte Aufl. - Berlin : Springer, 2007. - 707 S. : Ill.

III Internet resources

1. Science in Public: https://www.scienceinpublic.com.au/
2. European Commission (2018). *Science, research and innovation performance of the EU. Strengthening the foundations for Europe's future*. Pieejams: https://ec.europa.eu/info/sites/info/files/rec-17-015-srip-report2018_mep-web-20180228.pdf
3. Sage Journals Online http://online.sagepub.com/
4. http://www.wipo.int
5. http://www.european-patent-office.org
6. https://worldwide.espacenet.com/

Title of the course: Laser systems

RAIS code: awarded by

RAIS Credit points: 4

ECTS credits: 6

Total hours: 160

Number of lectures: 30 (F); 15 (P)

Number of seminars, workshops: 10 (F); 5 (P)

Number of lectures for students' individual work: 120 (F); 140 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Guest Assistant prof. PhD Ivaylo Balchev, RTA

Course abstract: This course introduces doctoral students to the science of laser systemsand their applications. It includes the detailed requirements for laser action in various media with an emphasis on the materials and optical cavities necessary to generate the spectrum of laser emission wavelengths and temporal properties needed for current industrial and scientific use. The relationship between the structure/properties with the performance/applications of the lasers will be a common theme throughout the course.

Aim of the course: The aim of the course is to give doctoral students the opportunity to improve their research and academic competence in the area of laser systems and their applications.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**

Knowledge (knowledge and understanding): - Understand the theory of photonics (laser technology), scientific findings, current scientific trends in Europe and the world, including from an interdisciplinary perspective. - Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach toresearch. - Is able to demonstrate the basic and specialized knowledge in the field of laser technology and this critical understanding, whichcorresponds to the highest level of scientific achievement.	- Knows and understands research methods and relevant scientific theories and conclusions. - Knows quantitative and qualitative research methods and methodologies in laser systems and interdisciplinary approach to research in contact with other disciplines.	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations
Skills (ability to apply knowledge, communication, general skills):	- To independently evaluate and select qualitative research methods and methodology appropriate for research.	Workshops, presentations, manuscript (written) developme nt	Workshops, presentations, manuscript (written) developme nt

-Is able to plan and conduct research in laser technologies, prepare publications at an internationally cited level, patent applications and create innovations. -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice.	- To solve significant research or innovation tasks , in the field of laser systems, by independently defining and formulating a research idea using appropriate research methods, critical analysis, synthesis and evaluation		
Competencies (analysis, synthesis and evaluation): -Is able to put forward a research idea, plan and manage high-level national and international scientific projects. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase	- Apply technologies in data processing and analysis to develop original scientific research based on qualitative research methods. - Creating innovative solutions for experimental and theoretical research, carrying out independent and critical analysis and evaluation of complex research problems in the field of laser systems.	Workshops, presentations, manuscript (written) developme nt	Workshops, presentations, manuscript (written) developme nt

Course content

No.	Course content (according to the volume and title of the study coursetopics, forms of testing)	Number of contact hours	
		F	P
Topic: Solid state lasers			
1.	Ruby laser	2	1
2.	Pumping techniques in solid state lasers	1	
3.	Nd:YAG laser	2	1
4.	Disk lasers	2	1
5.	Titanium: sapphire laser	1	1
6.	Q-switching technique. Seminar, workshop.	4	2
Topic: Semiconductor lasers			
1.	Principle of semiconductor lasers	2	1
2.	Light- emitting diodes	1	1
3.	GaAs homojunction and heterojunction lasers	1	

4.	Quantum well devices	1	
5.	Applications. Seminar, workshop.	5	2
Topic: Gas lasers			
1.	Helium-Neon laser	1	1
2.	Carbon Dioxide lasers	2	1

3.	Argon Ion laser	1	
4.	Excimer laser	1	1
5.	Metal vapour lasers	2	2
6.	Krypton laser	1	
7.	Nitrogen laser	1	1
8.	Applications. Seminar, workshop.	5	2
Topic: Fiber lasers			
1.	Design and operation principle of fiber lasers	2	1
2.	High power fiber lasers	1	1
3.	Erbium fiber laser	1	

Students' individual work

Form of individual work	**Hours**	
	Full time studies	**Part time studies**
Preparation of a report and presentation on different qualitative research approaches in existing research in thecontext of their chosen research topic. Preparation for discussion with appropriate scientific and practical literature studies of laser systems.	30	30
Preparation of a report and presentation on qualitativeresearch design of the chosen research topic. Preparation for a discussion to evaluate the analysis of relevant scientific and practical literature research in the field of laser systems.	30	30
Preparation of a report and presentation on the collectionand analysis of qualitative research data of the chosen research topic. Preparation for discussion with appropriate theoretical and experimental research of other research groups in the areaof laser systems.	30	35
Preparation of a scientific manuscript (article) reflecting the method of research for the chosen research topic.	30	45

Form of testing: exam

Evaluation of learning outcomes

Full time studies	**Part time studies**
The total evaluation comprises:Activity during classes -10% Individual work - 40% Manuscript (Article) preparation - 50%	The total evaluation comprises:Activity during classes -5% Individual work - 45% Manuscript (Article) preparation - 50%

Requirements for final examination:
Prepared reports and presentations
Scientific manuscript prepared (article)

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Literature:
I Textbooks (~3-4)

1. Keith J. Kasunic (2016) Laser Systems Engineering, SPIE PRESS book
2. K. Thyagarajan and Ajoy Ghatak (2011) Lasers: Fundamentals and Applications (Graduate Texts inPhysics), Springer 2nd ed.
3. C. Breck Hitz, James Ewing, Jeff Hecht (2012) Introduction to Laser Technology, Wiley-IEEE Press;4th edition
4. Choudhary Nityanand and Verma Richa (2011) Laser Systems and Applications

II Additional literature(~5-6)

1. William T. Silfvast (2012) Laser Fundamentals, Cambridge University Press
2. Bachmann, Friedrich, Loosen, Peter, Poprawe, Reinhart (Eds.) High Power Diode Lasers, Technologyand Applications, Springer, 2007
3. Orazio Svelto (2010) Principles of Lasers, Springer, ISBN 978-1-4419-1302-9
4. University of Central Florida, National Center for Optics and Photonics Education (2016) LaserSystems and Applications, 2nd Edition, OP-TEC
5. National Center for Optics and Photonics Education (2018) Fundamentals of Light and Lasers, 3rdEdition, OP-TEC

III Internet resources (2-3)

1. PDF drive https://www.pdfdrive.com/laser-books.html
2. Journals elsevier https://www.journals.elsevier.com/optics-and-laser-technology
3. Laser Physics, IOP Publishing https://iopscience.iop.org/journal/1555-6611
4. Journal of Russian Laser Research, Springer https://www.springer.com/journal/10946

Project Nr. 8.2.1.0/18/A/016 "The reduction of fragmentation of the study programmes and strengthening the sharing of the resources in the study directions "Management, administration and real estate management" and "Mechanics and metalworking, heat power industry, heat engineering and mechanical engineering" at Rezekne Academy of Technologies"

4.

Title of the course: Laser Macro-technologyRAIS code: awarded by RAIS

Credit points: 4

ECTS credits: 6

Total hours: 160

Number of lectures: 30 (F); 15 (P)

Number of seminars, workshops: 10 (F); 5 (P)

Number of lectures for students' individual work: 120 (F); 140 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname: Lead researcher Dr.sc.ing. Lyubomir Lazov, RTA; Researcher Dr.sc.ing. A.Skromulis, RTA

Course abstract: The laser emits an intense coherent beam of light with some unique and extremely useful properties. As a result of its specific design and principle the laser, can be focused to a very small location, useful for applications requiring very high power densities, including cutting and other material processing procedures. The high spatial resolution of the laser is also useful for microscopic imaging and scanning applications. The laser light can be monochrome - the total energy of the beam is limited to a narrow wavelength range. Some lasers can be work in regime a series of pulses of a pulsed duration, short at seconds (ie 10^{-18} seconds).

In fact, each laser application has its own specific requirements regarding laser performance of sources. The wide technical range of different types of lasers operating in different modes makes it possible to realize a diverse set of product lines characterized by lasers aimed at growth opportunities and key applications. In each case, it is necessary to approach rigorously individually, offering a specific combination of high values of superior technical characteristics and high reliability.

Laser technologies has taken its place as a critical enabler of the twenty-first century. Laser technologies-based solutions are embedded in a wide range of industries that include industrial automation, textile processing, microelectronics, flat-panel displays and medical diagnostics, with continued applications in a growing variety of applications. The growth of these applications comes from two sources.

First, there are many applications where the laser displaces conventional technology because it can do the job faster, better, or more economically.

Secondly, there are new applications where the laser is the only possible workable tool .

Key laser applications include: semiconductor testing; manufacture of modern printed circuit boards; flat screen production; production of solar cells; medical and bio-tools; materials processing; cutting and welding of metals; control of industrial process and quality; marking; images and prints; graphic arts and display; and, research and development. For example, ultraviolet ("UV") lasers enable the transition to miniaturization, which stimulates innovation and growth in many markets. In addition, the emergence of industrial-grade ultrafast lasers continues to open new applications for laser processing.

Aim of the course: The aim of the course is to enable doctoral students to improve their research and academic skills in the use of quality research methods in research in laser technology. To develop the ability to formulate scientific tasks in the field of laser processing of materials. To find scientifically based and innovative solutions for specific technological applications of lasers in practice (industry, medicine, military).

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Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): - Understand the theory of photonics (laser technology), scientific findings, current scientific trends in Europe and the world, including from an interdisciplinary perspective. - Know and is able to reasonably choose modern research methods, adapt existing ones and develop newones based on an	- Knows and understands research methods and relevant scientific theories and conclusions. - Knows quantitative and qualitative research methods and methodologies in laser systems and interdisciplinary approach to research in contact with other disciplines.	Workshops, presentations, report preparation	Workshops, presentations, report preparation

interdisciplinary approach toresearch. - Is able to demonstrate the basic and specialized knowledge in the field of lasertechnology and this critical understanding, which corresponds to the highest level of scientific achievement.			
Skills (ability to apply knowledge, communication, general skills): -Is able to plan and conduct research in laser technologies, prepare publications at an internationally cited level, patent applications and create innovations. -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledgein laser technology and mechanical engineering, focusing on its application in practice.	- To independently evaluate and select qualitative research methods and methodology appropriate for research. - To solve significant research or innovation tasks , in the field of laser systems, by independently defining and formulating a research idea using appropriate research methods, critical analysis, synthesis and evaluation	Workshops, presentations, manuscript (written) developme nt	Workshops, presentations, manuscript (written) developme nt
Competencies (analysis, synthesis and evaluation): -Is able to put forward a research idea, plan and manage high-level national and international scientific projects. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase	- Apply technologies in data processing and analysis to develop original scientific research based on qualitative research methods. - Creating innovative solutions for experimental and theoretical research, carrying out independent and critical analysis and evaluation of complex research problems in the field of laser systems.	Workshops, presentations, manuscript (written) developme nt	Workshops, presentations, manuscript (written) developme nt

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Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
Topic 1: Laser Cutting 1 KP - **ECTS**			
1.	State of the laser cutting systems market- introduction. .Laser cutting technological systems and laser cutting sources suitable for cutting	1	
2.	Principle of laser cutting. Factors that influence the laser cutting process of laser cutting	2	2
3.	Laser cutting methods. Traditional cutting methods. Comparison between laser cutting and other cutting methods. Criteria forassessing the quality of shear. Examples of laser cutting	4	2
Topic 2: Laser Welding 1 KP - **ECTS**			
1.	Introduction. Laser sources suitable for welding	1	
2.	Laser welding methods. Comparison between laser welding andother welding methods	2	2
3.	Factors affecting the process of the laser welding. Application of laser welding.	4	2
Topic 3: Laser Marking and Engraving 1 KP - **ECTS**			
1.	Introduction. Laser sources suitable for Marking and Engraving	1	
2.	Laser Marking methods. Comparison between laser marking and other marking methods	2	2
3.	Factors affecting the process of the laser marking. Examples of laser marking and engraving.	4	2
Topic 4: Laser Drilling 1 KP - **ECTS**			
1.	Introduction. Laser sources suitable for Drilling.	1	
2.	Laser Drilling methods. Comparison between laser drilling and other drilling methods	2	2
3.	Factors affecting the process of the laser drilling. Applications oflaser drilling.	4	1
Topic 5: Laser Hardening 1 KP - **ECTS**			
1.	Introduction. Laser sources suitable for Hardening.	1	
2.	Laser hardening methods. Comparison between laser hardening and other hardening methods	2	2
3.	Factors affecting the process of the laser hardening. Examples of laser hardening.	3	0.5
Topic 6: Cladding 1 KP - **ECTS**			
1.	Introduction. Laser cladding equipment.	1	
2.	Laser cladding methods.	2	2
3.	Factors affecting the process of the laser cladding. Examples of laser cladding.	3	0.5

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Preparation of a report and presentation on different qualitative research approaches in area of laser technologies existing research in the context of their chosenresearch topic. Preparation for discussion with appropriate scientific andpractical literature studies in the laser macro-machining.	30	30
Preparation of a report and presentation on the selectedresearch topic and the choice of laser source and other research equipment. Preparation for a discussion to evaluate the analysis of relevant scientific and practical literature research in thefield of laser macro processing.	30	30
Preparation of a report and presentation on the conductedexperimental and theoretical research on the selected research topic. Preparation for discussion with appropriate theoretical andexperimental research of other research groups in the scientific space.	30	35

Preparation of a scientific manuscript (article), reflecting the methodology and results of the research on the researchtopic chosen by the doctoral student.	30	45

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
The total evaluation comprises:Activity during classes -10% Individual work - 40% Manuscript (Article) preparation - 50%	The total evaluation comprises:Activity during classes -10% Individual work - 40% Manuscript (Article) preparation -50%

Requirements for final examination:
Prepared reports and presentations
Scientific manuscript prepared
(article)

Literature:
I Textbooks

5. John Dowden (Ed.), The Theory of Laser Materials Processing: The Theory of Laser MaterialsProcessing:Springer, 2009, ISBN-13 978 4020 9339-5 (HB)
6. Reinhart Poprawe, Laser Fundamentals, Springer, 2005, ISBN 3540443797
7. Poprawe, Reinhart (Ed.),Tailored Light 2, Springer, 2011, 621 p, ISBN 978-3-642-01236-5
8. Poprawe, Reinhart (Ed.), Tailored Light 1, High Power Lasers for Production, Springer, 2018, 271 pages, ISBN 978-3-642-01234-1

II Additional literature(~5-6)

6. William M. Steen, Jyotirmoy Mazumder,. Laser Material Processing, Springer, 2010, 558 p. ISBN 978-1-84996-062-5
7. **Katayama**, Seiji, Fundamentals and Details of Laser Welding, Springer, 2020, 198 p. ISBN 978-981-15-7933-2
8. Veiko, Vadim, Konov, Vitaly I, Fundamentals of Laser-Assisted Micro- and Nanotechnologies, Springer, 2014, 313 p., ISBN 978-3-319-05987-7
9. Advanced Materials and Technologies, Laser Applications, Springer, 2004, 302 p., ISBN 978-3-540-00105-8
10. Gupta, Pradeep Kumar, Khare, Rajeev, Laser Physics and Technology, Springer, 2012, 345 p., ISBN 978-81-322-2000-8

III Internet resources (2-3)

1. https://lia.scitation.org/journal/jla
2. https://onlinelibrary.wiley.com/page/journal/2365709x/homepage/best-of-advanced-materials- technologies-2018.html
3. https://www.journals.elsevier.com/optics-and-laser-technology

Title of the course: Laser Assisted Additive Manufacturing and MNTsRAIS code: awarded by RAIS

Credit points: 4

ECTS credits: 6

Total hours: 160

Number of lectures: 30 (F); 15 (P)

Number of seminars, workshops: 10 (F); 5 (P)

Number of lectures for students' individual work: 120 (F); 140 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Rousse Univerity "A.Kanchev" (UR) Course developer: scientific / academic degree, position, name, surname:

Associate prof. PhD Roussi Minev

Requirements for the course: Experience in mechanical and manufacturing engineering, CAD/CAM technologies, Design for manufacturing, Physics and chemistry.

Aim of the course: The aim of the course is to develop some theoretical understanding and acquaintance of the young researcher with the additive technologies as well as with the basic processes in MNTs toolbox. To develop some skills in implementation, selection, assessment, evaluation and research in Rapid prototyping technologies and MNTs, more particularly with those involving laser technologies.

Course abstract: This course develops the students' appreciation of the range of rapid prototyping (RP) technologies and the impact that these are increasingly having on the product development life cycle. A detailed study is provided of the relevant additive and subtractive methods of manufacture as well as discussion, demonstrations, and hands on experience of preparing and modifying the appropriate data sets. The issues of process capabilities, accuracy & calibration as well as design for RP manufacture will be covered.The course also provides familiarization with the business and technical challenges of themost advanced micro/nano manufacturing technologies (MNTs) and their impact on the design of emerging and potentially disruptive innovative products. Students will beencouraged to integrate the acquired knowledge and experience on a wide range of techniques into the product prototyping elements of their final year project thus proving the form and function of the designs. The course is designed according to the recent development in RP&M technologies and is based on the existing and newly acquired FuseDeposition (FDM), Laser cutting, SLA (Stereo-lithography).

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Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): - Understand the importance of laser technologies in the development of the national economy, in solving technical problem situations in certain sectors, in the development of innovations. -Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach to research.	- understanding of the role and importance of layering technologies in modern industry; - awareness of the importance of the RP and MNT processes for the modern digital industry; - understanding the future trends of the technology development.	Workshops, Practical and laboratory exercises, Discussions, Presentations	Workshops, Practical and laboratory exercises, Discussions, Presentations
Skills (ability to apply knowledge, communication, general skills): -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice, - Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other people's work, including	- be able to make informed decisions when selecting rapid prototyping processes and MNTs for the production of prototype components; - understand the advantages and limitations of commercially available technologies; - prepare and modify complex datasets in preparation for manufacturing; - be aware of the trends in Rapid prototyping and manufacturing (RP&M) and MNT; - produce sophisticated functional 3D physical prototypes;	Workshops, Discussions, Presentations, Practical and laboratory exercises	Workshops, Discussions, Presentations, Practical and laboratory exercises

collaborating in an international context.			

Competencies (analysis, synthesis and evaluation): - Is able to independently and systematically find, analyzeand synthesize information using scientific databases, patents, etc. sources of information. - Is able to constantly transfer new knowledge to students, demonstrate scientific and professional independence.	- evaluate and compare examples of RP and MNT technologies; - be able to present the output from these undertaking to a variety of audiences; - critically evaluate the capabilities of the processes.	Workshops, Discussions, Practical and laboratory work	Workshops, Discussions, Practical and laboratory work

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Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	Rapid Prototyping Processes Rapid prototyping process overview. Liquid-based RP systems. Solid-based RP systems. Powder-Based RP Systems. Formative RP systems. Open source RP systems. Subtractive systems. Vacuum casting. Precision and Plaster Metal Casting. Post processing. Workshops, discussions, practical work.	10	5
2.	Data preparation for RP RP data formats. Data preparation and file repair. Accuracy and calibration. Reverse engineering. Workshops, discussions, practical work.	10	5
3.	Micro-manufacturing and Nanotechnology Emerging Trends. Energy assisted process: EDM, Laser Milling, FIB, lithographic processes, Micro milling. Micro-replication processes: Electroforming, Micro Injection moulding, Hot Embossing, Record to report (R2R). Workshops, discussions, practical work.	12	6
4.	Application and Examples Medicine and Bioscience applications. Automotive and Consumer products. Investment casting applications. Sensors and Actuators, Microelectromechanical systems (MEMS). Evaluation and Benchmarking. Examples and case studies. Workshops, discussions, practical work.	8	4

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies

Literature research and preparation for seminars. Fundamentals of Rapid prototyping. These will be linked to demonstrations and a range of workshop based practical sessions. Case studies will additionally be used to develop and understanding of the technologies and their application to product development.	20	25
Tutor led sessions aimed at assisting the students with developmental work related to their individual projects.	20	25
A visit(s) to a RP burro or company/research centre or/and MNT laboratory to familiarize with the common activities and practice in commercial utilisation of the RP&M. This will broaden the horizon of the studied techniques and their application.	20	25
Development of a project – research of the process capability or design of a part/system.	30	30

Form of testing: submission of an individual project and exam

Requirements for final examination:
Participation in workshops and lectures – 40%

Development of an individual project – 60%

Literature:
I Textbooks (~3-4)
1.L. Krajevsky, L. Ritzman, M. Malhotra, Operations Management - Processes and Supply Chains, PEARSON, ISBN: 9780133872132 (2010)
2.K. Chia, K.F., Leong, C.S. Lim, Rapid Prototyping - Principles and Applications, World Scientific, ISBN-13-978-981-277-897-0, (2010)
3.D. Pham, S. Dimov, Rapid Manufacturing, Springer-Verlag, London LTD, ISBN 978-1-4471-0703-3, (2001)

II Additional literature

1.A. Law, W. Kelton, Simulation Modelling and Analyses, McGraw-Hill, ISBN 0-07-100803-9, (1991)

2. R. Minev, E. Minev, Technologies for RP – basic concepts, quality issues and modern trends, Scripta Scientifica Medicinae Dentalis, v 2, N01, 2016, pp.12-22

3.S. Upcraft, R. Fletcher, The Rapid Prototyping Technologies, Assembly and Automation, v.23, Issue4, DOI:10.1108/01445150310698634, pp.318-330, (2003)

4.C. Weiss , Selective Area Laser Deposition for the Purpose of Ceramic Joining and Repair, doctoral dissertation, (2013), University of Connecticut Graduate School Collections, http://digitalcommons.uconn.edu/cgi/viewcontent.cgi?article= 6396&context =dissertations

5.E. Minev, Grid Method Studies of the Geometrical Uncertainties in Free Form and Micro Processes, A thesis submitted to the Cardiff University for the degree of Doctor of Philosophy, http://orca.cf.ac.uk/32291/1/2012MinevEPhD.pdf, (2012)

6.J. Kruth, et al, Binding mechanisms in selective laser sintering and selective laser melting, Proc. of 15th Solid Freeform Fabrication Symposium, 2004, Austin, Texas, pp.26-36.

7. E. Minev, E. Yankov, R. Minev, The RepRap Printer for Metal Casting Patternmaking – Capabilities and Application, Труды VIII Международной нучно-практической конференции „Прогрессивные литейные технологии", НИТУ МИСиС, 16-20 ноябр (2015), Москва, стр.300-303, ISBN 978-5-9903239-3-3

8.E. Minev, E. Yankov, R. Minev, The RepRap Printer for Metal Casting Patternmaking – Capabilities and Application, Труды VIII Международной нучно-практической конференции „Прогрессивные литейные технологии", НИТУ МИСиС, 16-20 ноябр (2015), Москва, стр.300-303, ISBN 978-5-9903239-3-3

9.Минев Е., Е. Янков, Р. Минев. Влияние на технологичните параметри на REPRAP 3D принтер върху точността и граповостта на получаваните модели, XXII International Scientific Technical Conference FOUNDRY 2015, Pleven, (2015), брой 12, стр. 29÷32, ISSN 1310-3946.

10. O'Neill et all., Advances in three-dimensional rapid prototyping of microfluidic devices for biological applications, Bio microfluidics ISSN19321058, ISBN 19321058, (2014)v.8, issue 5, p. 052112

11. S. Murphy, A. Atala, 3D Bio printing of Tissues and Organs, Nature Biotechnology, v. 32 no. 8, August (2014), pp. 773-785

12. S. Evoy et al., Dielectrophoretic Assembly and Integration of Nanowire Devices with Functional CSMOS Operating Circuitry, Microelectronic Engineering, (2004), v. 75, no. 1, pp. 31-42

13.S. Bigot, S. Dimov, R. Minev, T. Dobrev, Function and Length Scale Integration in Innovative Products - Technical Solutions and New Organizational Models, International Journal of Manufacturing Technology and Management (IJMTM), ISSN: 1368-2148, (2011) Vol. 23 No.3/4, pp.157-178, DOI: 10.1504/IJMTM.2011.045514

14.S. Dimov, E. Brousseau, R. Minev, S. Bigot, Micro and Nano Manufacturing: Challenges and Opportunities, Proceedings of the Institution of Mechanical Engineers, (IMEchE) Part C, Journal of Mechanical Engineering Science (2012), ISSN 0954-4062, v. 226 (C1), pp. 3-15

15.J. Nestler et al., (2009) 'Polymer Lab-on-Chip systems with integrated electrochemical pumps suitable for large scale fabrication', International Journal of Adv. Manufacturing Technologies. (2009), ISSN 0268-3768, DOI: 10.1007/s00170-009-1948-4

16.C. Moldovan et al., Biosensor Array Based Platform for Pesticide Detection, Sensor Letters (2013), 11(8), pp. 1519-1523

17.E. Minev, K. Popov, R. Minev, S. Dimov, V. Gagov, M. Packianather, Utilizing a grid method for accuracy study of micro SLA parts, 4M Conference, Plastipolis, Oyonnax, France, 2010, ISBN: 978-981-08-6555-9, pp. 257-260

18.E. Minev, K. Popov, R. Minev, S. Dimov, V. Gagov, Grid Method for Accuracy Study of Micro Parts Manufacturing (2011) Micro and Nano systems (MNS), ISSN: 1876-4029, DOI:10.2174/1876402911103030263, 3 (3), (2011), pp. 263-269

19.P. Vella, E .Brousseau, R. Minev, S. Dimov, A Methodology for Maturity Assessment of Micro and Nano Manufacturing Process Chains, Proc. ICOM (2010), Wisconsin, USA, ISBN: 978-981-08-6555-9, pp.327-334

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III Internet resources

1. http://formlabs.com/
2.http://replicatorinc.com/blog/2010/02/solido-2950-3d-printer/
3.REPRAP MAGAZINE, issue 1, February 2013, www.reprapmagazine.com
4.https://ec.europa.eu/research/infrastructures/pdf/euminafab.pdf
5.http://www.dsm.com/products/somos/en_US/home.html

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Title of the course: Laser Safety and Medical TechnologyRAIS code: awarded by RAIS

Credit points: 3

ECTS credits: 4,5

Total hours: 120

Number of lectures: 20 (F); 10 (P)

Number of seminars, workshops: 10 (F); 5 (P)

Number of lectures for students' individual work: 90 (F); 105 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Assist. Prof. PhD Eng. Tsanko Karadzhov, Ruse University, Bulgaria

Course abstract:

Laser radiation has a high energy density, which can injure tissues or humanorgans, resulting in irreversible health consequences, if used incorrectly witha laser device.

The study course will give information the effect of laser radiation on humans.The principles of laser safety and safe operation with laser equipment have been considered. Information on glasses and other protective equipment is provided, depending on the type and power of the lasers.

Aim of the course: The aim of the course is to enable PhD students to improve their research and academic skills in the use of innovative methods in research in field of Laser Safety and Medical Technology.

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Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): Understand the theory of photonics (laser technology), scientific findings, current scientific trends in Europe and the world, including from an interdisciplinary perspective.	- Knows research methods in laser safety and interdisciplinary approach to research in contact with other disciplines. - Knows and understands research methods and relevant scientific theories and conclusions	Workshops, presentations, report preparation	Workshops, presentations, report preparation
Skills (ability to apply knowledge, communication, general skills): - Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other people's work, including collaborating in an international context. - Is able to communicate both orally and in writing about field of scientific activity with the scientific community and society, providing a new understanding of it.	- To independently evaluate and reasonably choose methods and methodologies suitable for scientific research in changing circumstances. - To independently evaluate and select qualitative research methods and methodology appropriate for scientific research in Laser Safety and Medical Technology	Workshops, presentations, manuscript (article) development	Workshops, presentations, manuscript (article) developme nt
Competencies (analysis, synthesis and evaluation): - Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information. - Is able to constantly transfer new knowledge to students, demonstrate scientific and professional independence.	- Apply technology to improve laser safety, data analytics and forecasting through original research, some of which is internationally published and cited. - Apply technologies in data processing and analysis to develop original scientific research based on qualitative research methods in Laser Safety and Medical Technology	Workshops, presentations, manuscript (article) development	Workshops, presentations, manuscript (article) developme nt

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Course content

No.	Course content (according to the volume and title of the study coursetopics, forms of testing)	Number ofcontact hours	
		F	**P**
Topic: General information related to laser safety and the operation of laser systems			
1.	Historical remarks	1	0.5
2.	General considerations	1	0.5
3.	Prior to starting work. Optics	2	1
4.	Laser safety tools. Seminar, workshop.	2	1
Topic: Laser Classes and Protective Measures			
1.	Laser safety regulations	1	0.5
2.	Laser hazard categories and laser classes	2	1
3.	Laser signs and labels	1	0.5
4.	Protective measures. Seminar, workshop.	3	1.5
Topic: Biologicals effects of laser radiation			
1.	Laser interaction with biological tissues	2	1
2.	Absorption and depth of penetration of electromagnetic radiation into water	2	1
3.	Laser radiation & eye	2	1
4.	Interaction to the skin. Seminar, workshop.	3	1.5
Topic: Laser Safety Goggles			
1.	Beam divergence and nominal ocular hazards distance (nOHD)	1	0.5
2.	Maximum permissible exposure (MPE)	1	0.5
3.	Laser safety filter technology	2	1
4.	Marking of laser goggles	1	0.5
5.	Instructions for care & Cleaning. Seminar, workshop.	3	1.5

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Preparation of a report and presentation on different research approaches in existing research in the context oftheir chosen research topic. Preparation for discussion with appropriate scientific andpractical literature studies.	25	30
Preparation of a report and presentation on laser safety onthe selected research topic. Preparation for discussion with appropriate scientific and practical literature research.	25	25
Preparation of a report and presentation on the optimizationin field of Laser Safety for the selected research topic. Preparation for discussion with appropriate scientific andpractical literature research	20	25
Preparation of a scientific manuscript (article) reflecting the method of research for the chosen research topic.	20	25

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
The total evaluation comprises:Activity during classes -10% Individual work - 40% Manuscript (Article) preparation - 50%	The total evaluation comprises:Activity during classes -5% Individual work - 50% Manuscript (Article) preparation - 45%

Requirements for final examination: Prepared reports and presentations Scientific manuscript prepared (article)

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Literature:

I Textbooks

1. Henderson, R., K. Schulmeister, Laser Safety. 1st Edition, CRC Press, 1st edition, 2013, ISBN-10 : 0750308591, ISBN-13 : 978-0750308595.
2. Barat, K., Laser Safety Management. Optical Science and Engineering, 1st Edition, CRC Press, 1stedition, 2006, ISBN-10 : 0824723074, ISBN-13 : 978-0824723071.
3. Winburn, D., Practical Laser Safety. CRC Press LLC, 2019, ISBN 0367403285, 9780367403287

II Additional literature

1. Henderson, A., Guide to Laser Safety. Springer US, 1997, ISBN 978-0-412-72940-9.
2. Meschede, D., Optics, Light, and Lasers: The Practical Approach to Modern Aspects of Photonics and Laser Physics. Wiley-VCH Verlag GmbH & Co. KGaA, 2017, Print ISBN:9783527413317, Online ISBN:9783527685486.
3. Milonni, P., J. Eberly, Laser Physics. Copyright © 2010 John Wiley & Sons, Inc., Print ISBN:9780470387719, Online ISBN:9780470409718.
4. Waynant, R., Lasers in Medicine. 1st Edition, CRC Press; 1st edition, 2001, ISBN-10 : 0849311462, ISBN-13 : 978-0849311468.
5. Silfvast, W., Laser Fundamentals. Cambridge University Press, 2012, ISBN: 9780511616426.

III Internet resources

1. https://spie.org/news/9-essentials-of-laser-safety?SSO=1
2. https://www.rp-photonics.com/laser_safety.html

7.

Title of the course: Modelling and simulations of laser technologiesRAIS code: awarded by RAIS

Credit points: 3

ECTS credits: 4,5

Total hours: 120

Number of lectures: 20 (F); 10 (P)

Number of seminars, workshops: 10 (F); 5 (P)

Number of lectures for students' individual work: 90 (F); 105 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Major Ass. Prof. PhD eng. Nikolay Angelov, Ruse University, Bulgaria

Course abstract: The course helps to increase the research competence of doctoral students. They thoroughly study the interaction of laser radiation with matter, the physical mechanisms of the absorption of laser radiation in different media, physical and mathematical models of the processes of heating, melting and evaporation of the material in the impact zone. The doctoral students get acquainted with methods for research of laser technological processes, learn and use specialized software for laser-induced temperature fields in the area of impact. They learn to plan and conduct numerical experiments to optimize specific technological parameters.

Aim of the course: The aim of the course is to enable PhD students to improve their research and academic skills in the use of research methods in research, to develop the ability to model different laser processes and to be able to choose and use appropriate software for simulations of various laser technologies.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the	Examination form	
		Full time studies	**Part time studies**

	end of the course capable)		
Knowledge (knowledge and understanding): - Understand the theory of photonics (laser technology), scientific findings, current scientific trends in Europe and the world, including from an interdisciplinary perspective. - Know and is able to reasonablychoose modern research methods, adapt existing ones anddevelop new ones based on an interdisciplinary approach toresearch.	- Knows research methods in laser technology and interdisciplinary approach to research in contact with other disciplines. - Knows and understands research methods and relevant scientific theories and conclusions	Workshops, presentations, report preparation	Workshops, presentations, report preparation
Skills (ability to apply knowledge, communication, general skills): - Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice. - Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other people's work, including collaborating in an international context.	- To evaluate independently and reasonably choose methods for laser marking, engraving, cutting, welding, etc. suitable forresearch. - To independently evaluate and select research methods appropriate for scientific research	Workshops, presentations, manuscript (article) development	Workshops, presentations, manuscript (article) developm e
Competencies (analysis, synthesis and evaluation): - Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase	- Optimization of laser technological processes through numerical experiments, presentation of original research and publication in international conferences or journals. - Apply technologies in data processing and analysis to develop original scientific research based on qualitative researchmethods.	Workshops, presentations, manuscript (written) developme nt	Workshops, presentations, manuscript (written) developme nt

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Course content

No.	Course content (according to the volume and title of the study coursetopics, forms of testing)	Number of contact hours	
		F	P
Topic: Laser Materials Interactions			
1.	Absorption of Laser Radiation	1	0.5
2.	Thermal Effects – Heating, Melting and Vaporization. Considerations forThermal Analysis	3	1.5
3.	Vapor Expansion and Recoil Pressures	2	1
4.	Plasma Formation	2	1
5.	Ablation	2	1
Topic: Heat and Fluid Flow			
1.	Energy Balance During Processing	2	1
2.	Heat Flow In The Workpiece. Temperature Distribution. Peak Temperatures. Cooling Rates. Thermal Cycles. Gaussian Heat Source. The Two-Temperature Model. Seminar, workshop.	3	1.5
3.	Fluid Flow Molten Pool. Continuity Equation. Navier–Stokes Equations. Surface Tension Effect. Free Surface Modelling. Seminar, workshop.	3	1.5
Topic: Laser Impact on Metal and Steels			
1.	Absorption of Metallic Materials. The Drude Model of Absorption. Temperature Dependence of the Absorption of Metals. Seminar, workshop.	3	1.5
2.	Influence of the Surface Condition. Energy Transport Equation. Heat Conduction Mechanisms. Temperature-Dependent Thermo-physicalConstants. Seminar, workshop.	3	1.5
3.	Examples with Femtosecond Laser. Opportunities and Work with the TEMPERATURFELD3D Program for Calculation of Laser-InducedTemperature Fields. Conduct Numerical Experiments. Workshop.	6	3

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Preparation of a report and presentation on different research approaches in existing research in the context of their chosen research topic. Preparation for discussion with appropriate scientific and practical literature studies.	20	25
Preparation of a report and presentation on a specific laser technology on the selected research topic. Preparation for discussion with appropriate scientific and practical literature research.	20	25
Preparation of a report and presentation on the optimization of a laser process through numerical experiments for the selected research topic. Preparation for discussion with appropriate scientific and practical literature research	20	25

Preparation of a scientific manuscript (article) reflecting the method of research for the chosen research topic.	30	30

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
The total evaluation comprises:Activity during classes -10% Individual work - 40% Manuscript (Article) preparation - 50%	The total evaluation comprises:Activity during classes -5% Individual work - 50% Manuscript (Article) preparation - 45%

Requirements for final examination:
Prepared reports and presentations
Scientific manuscript prepared
(article)

Literature:

I Textbooks

1. Holman, J., Heat Transfer, 10th Edition, McGraw-Hill, SBN 978–0–07–352936–3, 758 p.
2. Sidebotham, G., Heat Transfer Modelling, Springer International Publishing, Switzerland, 2015,ISBN 978-3-319-14513-6
3. Srinivasacharya, D., K. Reddy, Numerical Heat Transfer and Fluid Flow, Springer, Singapore,2018, ISBN 978-981-13-1902-0
4. Dowden, J., W. Schulz, The Theory of Laser Materials Processing, Springer Series in MaterialsScience, 2017, 425 p.

II Additional literature

1. Kreith, F., R. Manglik, M. Bohn, Principles of Heat Transfer, CENGAGE Learning, 2011, 784p.
2. Kakac, S., Y. Yener, C. Naveira-Cotta, Heat Conduction, CRC Press, 2018, 542 p., ISBN9781138943841
3. Hong, C., Computer Modelling of Heat and Fluid Flow in Materials Processing, Boca Raton,2014, 272 p., eBook ISBN 9780429187094 (2019)
4. Samarskii A.,P. Vabishchevich, Computational Heat Transfer, Publ. Wiley, 1996, 418 p.
5. Hahn, D., M. Ozisik, Heat Conduction, 3rd ed., John Wiley & Sons, Inc., 2012, 734 p. , ISBN 978-0-470-90293-6
6. Ossi, P., Advances in the Application of Lasers in Materials Science, Springer Series in MaterialsScience, 2018, 385 p.

III Internet resources

1. https://aapt.scitation.org/doi/10.1119/1.3694080
2. https://www.amazon.com/Thermal-Conductivity-Properties-Applications-Physics/dp/1441934448
3. https://www.springer.com/gp/book/9783030270520

8.

Title of the course: Laser Technologies for Security and DefenseRAIS code:
awarded by RAIS

Credit points: 2

ECTS credits: 3

Total hours: 80

Number of lectures: 14 (F); 8 (P)

Number of seminars, workshops: 6 (F); 4 (P)

Number of lectures for students' individual work: 60 (F); 68 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Prof. Dr.sc.ing. Edmunds Teirumnieks

Course abstract: The study course is intended for in-depth knowledge of the range of applications of modern laser technologies in the field of security and defence, their integrated approach between civil and military. Emphasis is placed on both non-lethal and lethal technologies and their specific applications in different environments - air, land and water. After completing the study course, the doctoral student must be able to clearly describe the main application possibilities and specifics of the types of lasers (fiber, solid, CO_2 and semiconductor lasers) in the field of safety and defence, depending on their power and other parameters.
Aim of the course: To provide knowledge about the latest trends and peculiarities of laser application in the field of defence and security.

Learning outcomes:

Learning outcomes of the study program	**The expected learning outcomes of the study course for the achievement of learning outcomes of the study program (student at the end of the course is able)**	**Testing of learning outcomes**	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): -Understand the theory of photonics (laser technology), scientific findings, current scientific	-Is familiar with the application of laser technology in the field of security and defence in solving specific tasks; - Knows the latest developments in lasers for safety and defence.	Workshops, discussions, presentations	Workshops, discussions, presentations

trends in Europe and the world, including from an interdisciplinary perspective. -Understand the importance of laser technologies in the development of thenational economy, in solving technical problem situations in certain sectors, in the development of innovations.			
Skills (ability to apply knowledge, communication, general skills): Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice.	- Capable of evaluate lasers for specific military or security applications; - Is able to combine the use of civil and specific lasers depending on the task.	Workshops, discussions, presentations	Workshops, discussions, presentations
Competencies (analysis, synthesis and evaluation): -Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase scientific qualification.	- Is able to define requirements for laser systems depending onthe specifics of their application; - Is able to assess the dangers of lasers and determine their safe use.	Workshops, discussions	Workshops, discussions

Course content:

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	Strategic and tactical laser systems	1	0.5
2.	Auxiliary laser systems of directional action	1	0.5

3.	Non-lethal laser weapon	1	0.5
4.	Laser tracking and control systems. non-contact laser sensors	1	0.5
5.	Laser exposure assessments (impact on elements of space rocket systems, impact on UAV (*unmanned aerial vehicle)* structural elements, effects on mines and ammunition, effects on the organs of vision, aiming accuracy, accounting for the divergence of laser radiation in the atmosphere)	6	3
6.	Laser designators (methods of high precision aiming of a projectile at a target, target indicators for small arms, precision strike guidance, target designators for high-precision ground weapon systems, optoelectronic systems for aviation)	5	2.5
7.	Laser radars (LIDAR's) (three-dimensional 3D laser location using matrix receivers, backscatter interference compensation, laser scanning, LIDAR guidance systems, LIDAR complexes of remote sensing of the atmosphere)	5	2.5

Students' individual work

Form of individual work	**Hours**	
	Full time studies	**Part time studies**
Preparing for the exam	15	15
Preparation of a report according to the chosen topic	30	38
Preparation of a report presentation on the chosen research topic	15	15

Form of testing: exam

Requirements for final examination:
Participation in workshops and lectures – 40%
Development of report and presentation – 60%

Literature:

I Textbooks

1. Feickert Andrew, Specialist in Military Ground Forces, *U.S. Army Weapons-Related Directed Energy (DE) Programs: Background and Potential Issues for Congress*, February 12, 2018.
2. *Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress*, Updated December 17, 2019.

II Additional literature

1. Ronald O'Rourke, Specialist in Naval Affairs, *Navy Shipboard Lasers for Surface, Air, and Missile Defense: Background and Issues for Congress*, June 12, 2015.

III Internet resources

1. https://thebulletin.org/2015/05/navys-new-laser-weapon-hype-or-reality/
2. https://www.popularmechanics.com/military/weapons/a28636854/powerful-laser-weapon/
3. https://www.armyrecognition.com/march_2017_global_defense_security_news_industry/u.s._army_demonstrates_mehel_2.0_laser_weapon_integrated_on_stryker_8x8_armoured_vehicle_11803171.html
4. https://www.militaryaerospace.com/home/article/14180250/military-laser-weapons

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5. https://www.sciencedirect.com/science/article/pii/S2214914719312231 (Survey and technological analysis of laser and its defense applications)

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9.

Title of the course: Sensor networks and sensor data processingRAIS code: awarded by RAIS

Credit points: 2

ECTS credits: 3

Total hours: 80

Number of lectures: 14 (F); 8 (P)

Number of seminars, workshops: 6 (F); 4 (P)

Number of lectures for students' individual work: 60 (F); 68 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Prof. Dr.sc.ing. A.Teilāns

Prerequisites
Physics and informatics courses have been acquired at previous study levels.

Course abstract: The aim of the study course is to provide an in-depth insight into the existing measurement data acquisition, transmission and processing technologies in industry and science.

Aim of the course: The study course will provide knowledge about real-time sensor measurement techniques, measurement data transmission and processing technologies, and the principles of sensor network design. Doctoral students will be introduced theoretically and practically to the techniques required for obtaining and processing research data.

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Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): - Understand the importance of laser technologies in the development of the national economy, in solving technical problem situations in certain sectors, in the development of innovations. - Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach to research.	1. For direct acquisition of sensor data by providing real-time measurements. 2. For the acquisition of derived measurement and process event data by providing pre-processing technologies for data obtained from related processes. 3. Knowledge of data transportation techniques, transmission protocols and architecture layers of computer network sand sensor networks.	Workshops, presentations, paper preparation	On line Workshops, presentationsand paper preparation
Skills (ability to apply knowledge, communication, general skills): -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering,	-Depending on the basis of previous education, skills are acquired or improved in obtaining the sensor measurement data necessary for research. -Acquires skills in sensor network design and application of data	Workshops, presentations, paper preparation	On line Workshops, presentationsand paper preparation

focusing on its application in practice. -Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other people's work, including collaborating in an international context	transportation technologies. -Acquires skills in designing structured operational data and historical serial data databases and data warehouses.		
Competencies (analysis, synthesis and evaluation): -Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase	- Providing technological processes and scientific research with the data necessary for research, management and administration.	Workshops, presentations, paper preparation	On line Workshops, presentationsand paper preparation

Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	Acquisition of sensor data by providing real-time measurements.	1L	1L
2.	Sensor data processing technologies.	4L	2L
3.	Data transfer technologies.	3L	1L
4.	Architectural layers of sensor networks.	6L	4L
5.	Practical work – design of prototype for sensor solution and data processing.	4P+2S	2P+2S

*** L - lecture, P- practical work, S- seminar**

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Practical work on the development of a prototype of sensor measurements required for the student's research, or a report containing a literature review and prototype design on the measurements and measurement processing technologies required for the student's research.	60	68

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
1. Evaluation of the sensor solution developed in practical classes and independent work - 25% 2. Evaluation of sensor data processing obtained in practical classes - 25% 3. Final test - exam - 50%	1. Evaluation of the sensor solution developed in practical classes and independent work - 25% 2. Evaluation of sensor data processing obtained in practical classes - 25% 3. Final test - exam - 50%

Requirements for final examination:

A sensor solution has been developed in a practical classes and during the independent work.

Literature:

I Textbooks (~3-4)

1. Intelligent Sensor Networks: The Integration of Sensor Networks, Signal Processing and Machine Learning 1st Edition. Fei Hu (Editor), Qi Hao (Editor) ISBN 9781138199743 Published November 15, 2016 by CRC Press 674 Pages 330 B/W Illustrations
2. Handbook of Modern Sensors: Physics, Designs, and Applications 5th Edition, Jacob Fraden (Author)
3. Sensor Technology Handbook. Jon S. Wilson | Dec 21, 2004. ISBN-10 : 0750677295

II Additional literature(~5-6)

1. Introduction to Mechatronics and Measurement Systems 5th Edition By David Alciatore ISBN10: 1259892344 ISBN13: 9781259892349
2. Industrial Wireless Sensor Networks: Protocols and Applications Hardcover – December 7, 2020 by Seong-Eun Yoo (Editor), Taehong Kim (Editor). ISBN-10 : 3039436058
3. Randomly Deployed Wireless Sensor Networks 1st Edition, Kindle Edition by Xi Chen (Author) Publisher : Elsevier; 1st edition (June 18, 2020) Publication date : June 18, 2020
4. Artificial Intelligence Techniques in IoT Sensor Networks (Chapman & Hall/CRC Distributed Sensing and Intelligent Systems Series) 1st Edition, Kindle Editionby Mohamed Elhoseny (Editor), K Shankar (Editor), Mohamed Abdel-Basset (Editor) . Publication year 2021

III Internet resources (2-3)

1. International Journal of Sensor Networks ISSN online 1748-1287 ISSN print 1748-1279 https://www.inderscience.com/jhome.php?jcode=ijsnet

10.

Title of the course: Industrial discrete event simulation

RAIS code: awarded by RAIS

Credit points: 2

ECTS credits: 3

Total hours: 80

Number of lectures: 14 (F); 8 (P)

Number of seminars, workshops: 6 (F); 4 (P)

Number of lectures for students' individual work: 60 (F); 68 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Prof. Dr.sc.ing. A.Teilāns

Prerequisites

Probability theory and mathematical statistics have been mastered at previous study levels.

Course abstract: The application of statistical modelling to the modelling of complex systems and particularly production systems is considered. Students are introduced to the stages of the simulation life cycle and their implementation. In the practical part, students get acquainted with modern model simulation development software and acquire practical skills in using at least one software (for example, ExtendSim, Simul8, Arena).

Aim of the course: The aim of the study course is to provide knowledge and skills for a discrete event system in the field of simulation for industrial tasks.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledgeand understanding): - Understand the importance of laser technologies in the development of the national economy, in solving technical problem situations in certain sectors, in the development of innovations. - Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach to research.	- On discrete time simulation modelling. -On the use of statistical methods for adjusting model parameters. computer network sand sensor networks.	Workshops, presentations, paper preparation	On line Workshops, presentationsand paper preparation

Skills (ability to apply knowledge, communication, general skills): -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice. -Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other	-Development of simulation models with several software tools. -Skills in planning and runing experiments.	Workshops, presentations, paper preparation	On line Workshops, presentationsand paper preparation

people's work, including collaborating in an international context			
Competencies (analysis, synthesis and evaluation): -Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase	- The student acquires competencies in Systems Analysis and Modelling with the aim to prove the functionality and accuracy of the solution.	Workshops, presentations, paper preparation	On line Workshops, presentationsand paper preparation

Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	Using of Statistical modelling for design and analysis of complex systems.	4L	2L
2.	Modelling procedure stages of Discrete event system simulation modelling. Model design principles. Goal oriented models for alternative comparison, for system elements sensitivity analysis and for system parameters optimisation.	4L	2L
3.	Examples of Simulation applications and model implementation software tools. Design and application of production simulation model.	6L	4L
4.	Study of simulation modelling software (according to the student's choice: ExtendSim, Simul8, Arena) • Development and application of production system simulation model: • Model validation • Experimental planning and execution Analysis of modelling results	4P+2S	2P+2S

*** L - lecture, P- practical work, S- seminar**

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Study of simulation modelling software (at student's choice: Extend, Simul8, Arena)	60	68

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
1. Evaluation of the system model developed in practical classes and during the independent work - 25% 2. Evaluation of the analysis of the results of modelling experiments developed in practical classes - 25% 3. Final test - exam - 50%	1. Evaluation of the system model developed in practical classes and during the independent work - 25% 2. Evaluation of the analysis of the results of modelling experiments developed in practical classes - 25% 3. Final test - exam - 50%

Requirements for final examination:

A simulation model has been developed in a practical classes and during the independent work.

Literature:

I Textbooks (~3-4)

1. W. David Kelton, Randall P. Sadowski, David T. Sturrock Simulation with Arena. McGraw Series in Industrial Engineering and Management Science. 2014
2. Zeigler, B. P., Muzy, A., & Kofman, E. Theory of Modeling and Simulation: Discrete Event & Iterative System Computational Foundations. Academic Press. December 2018 DOI: 10.1016/C2016-0-03987-6. Edition: Third Edition of Theory of Modeling and Simulation (Praehofer and Kim) Publisher: Academic PressISBN: 9780128134078
3. Giuseppe Ciaburro. Hands-On Simulation Modeling with Python: Develop simulation models to get accurate results and enhance decision-making processes. Jul 17, 2020

II Additional literature(~5-6)

1. Philip J Thomas. Simulation of Industrial Processes for Control Engineers 1st Edition ISBN-13 : 978-0750641616
2. Discrete Event Simulation Using ExtendSim 8 First Edition by Jeffrey Strickland (Author) ISBN-13 : 978-1300790587
3. Discrete-Event Modeling and Simulation: A Practitioner's Approach (Computational Analysis, Synthesis, and Design of Dynamic Systems) 1st Edition by Gabriel A. Wainer (Author) ISBN-13 : 978-1420053364
4. Simulation Modeling with SIMUL8 Paperback – November 1, 2003 by Kieran Concannon (Author), Mark Elder (Author), Kim Hunter (Author), Jillian Tremble (Author), & 1 moreISBN-10 : 0973428503
5. Monte Carlo Simulation in Engineering Mikael Amelin KTH Royal Institute of Technology Electric Power Systems Stockholm. 2013

III Internet resources (2-3)

1. SNE - Simulation Notes Europe, https://www.eurosim.info/journal-sne
2. SIMULATION: Transactions of The Society for Modeling and Simulation International, https://journals.sagepub.com/loi/sim

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11.

Title of the course: LIDAR data processing

RAIS code: awarded by RAIS

Credit points: 2

ECTS credits: 3

Total hours: 80

Number of lectures: 14 (F); 8 (P)

Number of seminars, workshops: 6 (F); 4 (P)

Number of lectures for students' individual work: 60 (F); 68 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)

Course developer: scientific / academic degree, position, name, surname:

Assist. prof. Dr.sc.ing. Sergejs Kodors

Course abstract: Students obtain the basic knowledge about LiDAR data processing including practical skills through two industrial use cases. In the workshops, students are trained to develop two basic products of LiDAR data: a reconstructed 3D model and a digital surface model (DSM). Students get explanation about use cases, algorithms, tools and methods (including machine learning technologies), which apply developed products. Seminars include discussions about trends and possible research fields for doctoral students to improve their professional competence.

Aim of the course: the aim of the course is to give doctoral students the opportunity to develop their research and academic competence in LiDAR data processing.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledge and understanding): -Understand the theory of photonics (laser technology),	-Students know LiDAR data formats; -Students know coordinate systems;	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations

scientific findings, current scientific trends in Europe andthe world, including from an interdisciplinary perspective. -Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach to research.	-Students know LiDAR data processing tools.		
Skills (ability to apply knowledge, communication, general skills): -Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice. - Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other people's work, including collaborating in an international context.	-Students can reconstruct 3D models of scanned objects; -Students can generate DSM using LiDAR data. .	Workshops, Discussions, Presentations	Workshops, Discussions, Presentations
Competencies (analysis, synthesis and evaluation): -Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. -Is able to increase. Is able to constantly transfer new knowledge to students, demonstrate scientific and professional independence.	-Students are prepared to work in enterprises related with 3D object reconstruction using laser scanners; -Students are prepared to work in enterprises related with gaeospatial analysis and airborne laser scanning.	Workshops, Discussions	Workshops, Discussions

Course content

No.	Course content (according to the volume and title of the study course topics, forms of testing)	Number of contact hours	
		F	P
1.	Introduction. Use cases of *LiDAR* application	2	1
2.	Different types of laser scanning	1	1
3.	*LiDAR* data formats and LAS specification	2	2

4.	Reconstruction of 3D model: algorithms and tools. Workshop	5	3,5
5.	Geospatial analysis using LiDAR data: algorithms and tools. Workshop	8	3,5
6.	Development of research topics and discussions	2	1

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Development of research vision	45	53
Preparation of a presentation	15	15

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
The total evaluation comprises: 1. Activity during classes – 40% 2. Completed test - 20% 3. Developed research description and methodology - 20% 4. Presented vision of research - 10% 5. Completed experiment and developed draft of scientific publication – 10%	The total evaluation comprises: 1. Activity during classes – 40%; 2. Completed test - 20% 3. Developed research description and methodology - 20% 4. Presented vision of research - 10% 5. Completed experiment and developed draft of scientific publication – 10%

Requirements for final examination:

Completed workshop tasks.

Developed vision of research or completed experiment related with LiDAR data processing.

Literature:

I Textbooks (~3-4)

- Pinliang Dong, Qi Chen. LiDAR Remote Sensing and Applications, 2017.
- G Vosselman; Hans-Gerd Maas. Airborne and terrestrial laser scanning, 2010.
- G Saravana Kumar. Geometric Modeling Methods using Point Cloud Data: Computing Techniques for Recognition and Fitting of Free-form Curves and Surfaces, 2010.

II Additional literature(~5-6)

- Construction 4.0: An Innovation Platform for the Built Environment, 2020.
- Martin Weinmann. Reconstruction and Analysis of 3D Scenes: From Irregularly Distributed 3D Points to Object, 2016.

III Internet resources (2-3)

- Scientific databases (ResearchGate, GoogleScholar, EBSCO, Scopus, utt.)
- ASPRS, LAS SPECIFICATION (the last version)

Title of the course: Big data processing

RAIS code: awarded by RAIS
Credit points: 2
ECTS credits: 3
Total hours: 80
Number of lectures: 14 (F); 8 (P)
Number of seminars, workshops: 6 (F); 4 (P)
Number of lectures for students' individual work: 60 (F); 68 (P) Course approval date: (approved in the study direction council meeting)Department (faculty) in charge: Faculty of Engineering (RTA)
Course developer: scientific / academic degree, position, name, surname:

Prof. Dr.sc.ing. Pēteris Grabusts

Course abstract: During the course the doctoral students' research competence is improved, i.e., during the course the doctoral student thoroughly studies quantitative data research methods and basic questions of research methodology, is able to use quantitative research methods proficiently by performing scientific research in data analysis and entrepreneurship and related interdisciplinary fields.

Aim of the course: The aim of the course is to give doctoral students the opportunity to improve their research and academic competence in the use of big data analysis and research methods. Students will learn how to develop critical and analytical reasoning about big data processing, as well as to analyze and solve problems that arise in organizations that work on technological innovative projects using big data.

Learning outcomes:

Learning outcomes	Planned learning outcomes of the study course to achieve the study program outcomes (student at the end of the course capable)	Examination form	
		Full time studies	**Part time studies**
Knowledge (knowledgeand understanding): -Know and is able to reasonably choose modern research methods, adapt existing ones and develop new ones based on an interdisciplinary approach to research.	- Knows and understands quantitative research methods and corresponding scientific theories and conclusions. - Is able to demonstrate understanding of the most important concepts and regularities of the data analysis field.	Practical tasks, exam	Practical tasks, exam

Skills (ability to apply knowledge, communication, general skills): - Is able to give a new understanding of existing knowledge and is able to synthesize new knowledge in laser technology and mechanical engineering, focusing on its application in practice. - Is able to demonstrate and justify a scientific approach to problem solving, take responsibility and initiative, working individually, in a team or leading other people's work, including collaborating in an international context.	-Is able to formulate and analytically describe information, problems and solutions in the field of management of organisation, operations and technological innovation, explain them and discuss them reasonably with both specialists and non-specialists, - To independently evaluate and select quantitative research methods and methodology appropriate for scientific research	Practical tasks, exam	Practical tasks, exam

Competencies (analysis, synthesis and evaluation): -Is able to independently and systematically find, analyze and synthesize information using scientific databases, patents, etc. sources of information. - Is able to manage research processes in companies, solve innovation tasks, using the latest research-based knowledge. Able to increase scientific qualification.	- Apply technology, bigdata analytics and forecasting through original research, some of which is internationally cited -Apply technologies in data processing and analysis to develop original scientific research based on qualitative research methods.	Workshops, presentations, manuscript (written) development	Workshops, presentations, manuscript (written) development

Course content

No.	**Course content (according to the volume and title of the study course topics, forms of testing)**	**Number of contact hours**	
		F	**P**
1.	Big data concepts	2	1
2.	Data bases and data warehouses. Object databases. - Introduction to data bases - SQL concepts - Object relation databases - Data warehouse	4	2
3.	Artificial intelligence. Neural networks. - Data Mining and Knowledge Discovery - Clustering: Unsupervised Data Classification - Artificial Neural Networks - Fuzzy Logic - Workshop	6	4
4.	Predictive data analytics. - Types of data analytics - Basic concept of Predictive Analytics - Machine learning - Big data analytics - Workshop	4	3
5.	Business data retrieval technologies. Remote sensing, sensor networks and data processing. - Data acquition technologies. - Remote sensing, sensor networks - Wireless e-Nose sensor network system architecture - Networks for measurement processing - Workshop	4	2

Students' individual work

Form of individual work	Hours	
	Full time studies	Part time studies
Preparation of a report and presentation on quantitative research design of the chosen research topic. Preparation for discussion with appropriate scientific and practical literature studies.	20	20
Preparation of a report and presentation on the collection and analysis of quantitative research data of the chosen research topic (using neural networks)	20	20
Preparation of a scientific manuscript (article) reflecting the methodology of quantitative research of the chosen research topic.	20	28

Form of testing: exam

Evaluation of learning outcomes

Full time studies	Part time studies
The total evaluation comprises: Activity during classes -10% Individual work - 40% Manuscript (article) preparation - 50%	 10% 40% 50%

Requirements for final examination:
Prepared reports and presentations
Scientific manuscript prepared (article)

Literature:

I Textbooks

1. M. Kleppmann, Designing Data-Intensive Applications: The Big Ideas Behind Reliable,Scalable, and Maintainable Systems. O'Reilly, 2016.
2. N. Jukic, S. Vrbsky, S. Nestorov, Database Systems: Introduction to Databases and DataWarehouses. Prospect Press, 2017.
3. Giudici P. Applied Data Mining: Statistical Methods for Business and Industry. - JohnWiley & Sons Ltd., 2003.
4. Fausett L. Fundamentals of Neural Networks: Architectures, Algorithms and Applications. - NewYork: Prentice Hall International Inc., 1994.
5. M. Kuhn, K. Johnson, Applied Predictive Modeling. Springer, 2013.
6. B. Ratner, Statistical and Machine-Learning Data Mining: Techniques for Better PredictiveModeling and Analysis of Big Data, Second Edition. CRC Press, 2012.

II Additional literature

1. G. Tillmann, Usage-Driven Database Design: From Logical Data Modeling through PhysicalSchema Definition. Kindle Edition, 2017.
2. J. Eckstein, B. R. Schultz, Introductory Relational Database Design for Business, with MicrosoftAccess, Wiley, 2018.
3. C. Coronel, S.A. Morris, P. Rob, Database Systems: Design, Implementation, and Management:Design, Implementation, and Management. 10ed. Joe Sabatino Publisher, 2012.
4. Wierzchon, S. & Klopotek, M. (2018). *Modern Algorithms of Cluster Analysis*. Springer.
5. Tomaž Kos, Tomaž Kosar, and Marjan Mernik. Development of data acquisition systems byusing a domain-specific modeling language. *Computers in Industry*, 63(3):181–192, 2012.

6. V. Gonzalez (2012). *Data Acquisition in Particle Physics Experiments*. InTech.

III Internet resources

1. IBM SPSS Statistics (2018). Retrieved from https://www.ibm.com/lv-en/marketplace/spss-statistics
2. IBM SPSS Modeler (2018). Retrieved from https://www.ibm.com/products/spss-modeler
3. https://www.predictiveanalyticstoday.com/
4. https://www.controleng.com/articles/eight-data-acquisition-best-practices/
5. "Internet of things." [Online]. Available: https://en.wikipedia.org/w/index.php?title=Internet_of_things&oldid=865907229.

13.

Course title: Scientific Work Level of study programme:

PhD level Type of study course: Compulsory courseCourse workload: 90 credit points
Course teachers: Supervisors of doctoral theses
Study language: Latvian or English

Course summary: Scientific work is original research work conducted by the doctoral student independently (or in a team of researchers, specifying the exact contribution and workload) on a current or future problem in laser technologies field by using relevant research methods. The scientific work is prepared in the form of a written report as a doctoral thesis or a collection of scientific publications with an overview. The scientific work includes a theoretical part analysing and comparing the existing knowledge appliedin solving the problem and an empirical part describing the original research. The amountof the scientific work in a written form without annexes and the list of sources shall not exceed 150 pages. The summary of the scientific work is up to 30 pages.

Aim and competence: The aim is to independently plan the research development processin order to achieve the research results within a certain time period, incl. scientific publications on the topic of the research that can be presented in an international scientific and professional environment. The aim of the research is to create new knowledge and approbate it in the in industry or production.

Learning outcomes and their assessment: The doctoral student is able to identify and describe the research problem, make a reasoned choice of research methods, understand the limitations of the research, is able to define the boundaries of the research. The doctoral student is able to work with information sources, understands their credibility, and engages in scientific discussions with other research results. The doctoral student is able to critically evaluate the obtained research results and draw conclusions about the solutions to the problem. The solutions are offered by using the knowledge base and the empirical research. The study results are evaluated in the Joint Doctoral Study ProgrammeCouncil and after that in the Doctoral Council where reviewers evaluate the work and provide the student with a written review, as well as in the Doctoral Council's oral defencewhere the scientific work is presented. The doctoral student demonstrates his/ her skills by answering questions and participating in discussion with members of the Doctoral Council and reviewers.