Summer school syllabus

Title of the Summer School:

REGINNA 4.0 Third Summer School: «Deep Tech training on Industry 4.0, Artificial Intelligence, Nanotechnology and Entrepreneurship»

Objectives of the Summer School:

Training of talents in the technological areas of Industry 4.0 and Nanotechnology. This event will connect students with academics, businesses, public bodies and non-governmental organizations to explore innovations, business development and transfer of ideas from the laboratory to the market. Participants will familiarize with technologies and entrepreneurial potentials in the fields of Industry 4.0 and Nanotechnology. This includes artificial intelligence applied to real industrial problems, additive manufacturing and industrial cybersecurity and, in addition, advanced materials for nanoelectronics and quantum technologies. In addition, the participants will learn the basic skills to start a business, develop a business plan, understand marketing and financial management. Objectives are described in detail in the Syllabi of courses.

Competencies and learning outcomes of the Summer School:

Participants will obtain basic knowledge from Industry 4.0 including digital transformation, additive manufacturing, reverse engineering, enabling technologies, with a focus on automatic inspection using machine learning and deep learning. Students will also understand the relevance of cybersecurity in industrial control systems and critical infrastructures, the main threats and vulnerabilities in industrial control systems in contrast to traditional information systems and acquire a high-level view of the procedures and measures available to mitigate cybersecurity risks.

From the Nanotechnology field, the participants will gain general knowledge about nanomaterials and their properties. They will be able to identify different types of nanomaterials and distinguish between classical and quantum size effects. Participants will learn about the basic concept of quantum mechanics and quantum computing. And they will learn about recent progress and challenges in the field of quantum computing technologies.

Within the block of Entrepreneurship and Innovation, the participants will gain knowledge about the economic function of entrepreneurship, the strengths and weaknesses of different patterns to the start-up. In addition, they will obtain basic knowledge about different types of innovation and how to manage an innovation process. They will learn about different business models, problems and solutions, and they will consider examples of business models of well-known startups.

Evaluation criteria:

The evaluation of learning outcomes of the summer school will be conducted by means of an online exam. Participants who successfully complete the online exam will be issued with a certificate of participation in the Summer School.

Persons responsible for the certification purposes (who will sign the diplomas):

Vice Rector for Internationalization

Place and date of the summer school:

León, Spain, 12.04.2024, 19.04.2024 and 03.05.2024

Content of the Summer School:

REGINNA 4.0 Third Summer School comprises a total 50 hours of which 25 are contact hours and 25 are individual work hours. More details are available in the Syllabi of courses.

Host organization:

University of León – León - Spain

Host organization responsibles:

Víctor González Castro; Laura Fernández Robles, REGINNA 4.0 responsible faculty at the University of León

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union can be held responsible for them.

Summer School – Syllabi of courses

Title of the summer school:

REGINNA 4.0 Third Summer School: «Deep Tech training on Industry 4.0, Artificial Intelligence, Nanotechnology and Entrepreneurship»

List of courses

Section A. Industry 4.0			
Id	Course title	Contact hours	Individual work
A1	Digital transformation journey	1	1
A2	Introduction to machine learning	2	2
A3	Machine learning and computer vision in industry 4.0, use case 1	2	2
A4	Introduction to convolutional neural networks and its application in computer vision	2	2
A5	Machine learning and computer vision in industry 4.0, use case 2	2	2
A6	Additive manufacturing as a mean for supporting rapid development of innovative products	3	3
A7	Reverse engineering and inspection in digital factory	1	1
A8	Introduction to industrial cybersecurity	2	2

Section B. Nanotechnology			
Id	Course title	Contact hours	Individual work
B1	Nanomaterials: introduction	2	2
B2	Nanomaterials: magic of carbon	2	2
B3	An introduction to quantum computing	1	1

Section C. Entrepreneurship and Innovation			
Id	Course title	Contact hours	Individual work
C1	Innovation on the field (real cases)	1	1
C2	Entrepreneurship and start-up management	2	2
C3	Business strategies in high-innovation potential areas (nanotechnology, industry 4.0, artificial intelligence)	2	2
	TOTAL (hours)	**25**	**25**

SUMMER SCHOOL – SYLLABI OF COURSES **3**

LIST OF COURSES **3**

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A2. Introduction to Machine Learning 9
A3. Machine Learning and Computer Vision in Industry 4.0: Use case 1 10
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A6. Additive manufacturing as a mean for supporting rapid development of innovative products 13
A7. Reverse engineering and inspection in digital factory 14
A8. Introduction to Industrial Cybersecurity 15

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SECTION C. ENTREPRENEURSHIP AND INNOVATION **25**

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C2. Entrepreneurship and start-up management 28
C3. Business strategies in high-innovation potential areas (Nanotechnology, Industry 4.0, Artificial intelligence) 29

Section A. Industry 4.0

Course title:	A1. Digital Transformation Journey
Lecturer:	Massimiliano Bertetti
Affiliation:	Polo Tecnologico Alto Adriatico "Andrea Galvani" SCpA- Società Benefit

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
1					1

Assessment methods:	Written examination

Syllabus outline:

- Introduction to industry 4.0 (30')
- How to guide a Digital Transformation Project (30')
- Digital Transformation Project: evidences from the FVG firms (30')

Objective competences:

1 Comprehensive overview about digital transformation.
2.Knowledge acquisition about enabling technologies and digital use cases
3.Basic knowledge and methods about how to support a successful digital transformation inside the organizations

Intended learning outcomes:

1. To know the basic knowledge about digital transformation
2. To know about digital assessments
3. To know enabling technologies
4. To build a classification about tools and methods to guide digital transformation.

Literature
1. World Economic Forum – "Technology_and_Innovation_The_Next_Economic_Growth_Engine", in collaboration with McKinsey & Company , January 2018 2. World Economic Forum – "Fourth Industrial Revolution -Beacons-of-Technology-and-Innovation-in-Manufacturing" in collaboration with McKinsey & Company, January 2019 3. Industry4Business - https://www.industry4business.it/esperti-e-analisti/cantiere-digitale-il-modello-per-accelerare-i-progetti-di-digital-transformation/ 4. Industry4Business - https://www.industry4business.it/industria-4-0/lean-e-digital-motori-dellefficienza-operativa-aziendale/ 5. Industry4Business - https://www.industry4business.it/industria-4-0/le-imprese-del-friuli-venezia-giulia-alla-sfida-della-digitalizzazione/

Lecturer's references

Course title:	A2. Introduction to Machine Learning
Lecturer:	Rocío Alaiz Rodríguez
Affiliation:	University of León

Duration (hours)

Lectures	Seminar	Tutorial	Labora-tory work	Field work	Individ. work
2					2

Assessment methods:	Written examination

Syllabus outline:

1. Concept of Machine Learning and application fields. Slides: 15 minutes
2. Supervised and unsupervised learning. Slides: 20 minutes
3. Approaching a problem of learning from examples. Slides: 25 minutes
4. First (simple) classifier: K-Nearest Neighbours (K-NN). Slides: 10 minutes
5. Another classifier: Naïve Bayes. Slides: 20 minutes
6. Evaluating classifiers' performance. Slides: 30 minutes

Objective competences:

1. Comprehensive overview about machine learning basic concepts.
2. Understanding the fundamentals of training a classifier.
3. Basic knowledge about how to evaluate a classifier and how to interpret its results

Intended learning outcomes:

1. To know the basic knowledge about machine learning.
2. To understand the process of training a classifier
3. To know about two basic supervised learning classifiers: kNN and Naïve Bayes
4. To evaluate and interpret classification model results.

Course title:	A3. Machine Learning and Computer Vision in Industry 4.0: Use case 1
Lecturer:	Francisco Jáñez Martino, Alicia Martínez Mendoza
Affiliation:	University of León

Duration (hours)

Lectures	Seminar	Tutorial	Labora-tory work	Field work	Individ. work
			2		**2**

Assessment methods:	Written examination

Syllabus outline:

1. Use pretrained Support Vector Machine (SVM) traditional model to classify steel plates. Hands-on: 120 minutes.

1.1. Visualization of a classifier trained on computer vision.
1.2. Training and test data visualization.
1.3. Estimation of the class of independent examples using a pretrained model.

Objective competences:

1. To observe in practice the application of a SVM in image processing and classification.
2. To identify the parameters of SVM models and how they can affect the performance.
3. To learn to use traditional computer vision techniques to get descriptors to classify steel plates.

3.1. To get started with handcrafted descriptors.
3.2. To apply this knowledge to an Industry 4.0 problem.

Intended learning outcomes:

1. To classify steel plates depending on the type of surface defects in stainless steel plates, with six types of possible defects (plus "other") using traditional computer vision techniques.
2. To identify the parts of an image processing system.
3. To know how to evaluate the performance of a machine learning model.

Course title:	A4. Introduction to Convolutional Neural Networks and its application in Computer Vision
Lecturer:	Enrique Alegre Gutiérrez
Affiliation:	University of León

Duration (hours)

Lectures	Seminar	Tutorial	Labora-tory work	Field work	Individ. work
2					**2**

Assessment methods:	Written examination

Syllabus outline:
1. Neural Networks. Slides: 15 minutes 2. Image Convolution. Slides: 15 minutes 3. Convolutional Neural Networks. Slides: 35 minutes. 4. Issues with CNNs: 15 minutes 5. Some applications: 10 minutes

Objective competences:
1. Know the concept of convolution and its applications in image processing. 2. Identify the building blocks of a Neural Network and a Convolutional Neural Network. 3. Learn to use pretrained CNNs to get descriptors to classify images

Intended learning outcomes:
1. To know the basics about image convolution 2. To learn what a -neural Network is and its main concepts (neuron, layer, etc.). 3. To define how a Convolutional Neural Network works and its basic building blocks

Course title:	A5. Machine Learning and Computer Vision in Industry 4.0: Use case 2
Lecturer:	Roberto Andrés Carofilis Vasco, Alicia Martínez Mendoza
Affiliation:	University of León

Duration (hours)

Lectures	Seminar	Tutorial	Labora-tory work	Field work	Individ. work
			2		**2**

Assessment methods:	Written examination

Syllabus outline:
2. Use pretrained Convolutional Neural Networks (CNNs) to classify inserts. Hands-on: 120 minutes. 1.4. Visualization of the structure of a CNN architecture. 1.5. Training and test data visualization. 1.6. Estimation of the class of independent examples using a pretrained model.

Objective competences:
1. To observe in practice the application of a CNN in image processing. 2. To identify the building blocks of a CNN architecture. 3. To learn to use pretrained CNNs to get descriptors to classify the level of wear of milling inserts. 3.1. To get started with non-handcrafted descriptors. 3.2. To apply this knowledge to an Industry 4.0 problem.

Intended learning outcomes:
4. To classify inserts as having high or low wear using features extracted using pre-trained CNNs. 5. To identify the parts of an image processing system. 6. To know how to evaluate the performance of a machine learning model.

Course title:	A6. Additive manufacturing as a mean for supporting rapid development of innovative products
Lecturer:	**Sofía Peláez and Joaquín Barreiro**
Affiliation:	**Universidad de León**

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
2	**1**				**3**

Assessment methods:	Written examination

Syllabus outline:

1. What is additive manufacturing and its basic operating principle (10 minutes)
2. Review of groups of technologies and materials in additive manufacturing (40 minutes)
3. Capabilities, advantages, constraints and limits of additive manufacturing (15 minutes)
4. Application of additive manufacturing for innovating. Scope of application (15 minutes)
5. Trends and future of additive manufacturing (10 minutes)
6. Practical case using free software (45 minutes)

Objective competences:

1. Comprehensive overview of the different additive manufacturing technologies.
2. Knowledge about limits and advantages of additive processes compared to traditional manufacturing.
3. Basic knowledge about the actions for preparing, manufacturing and post-processing a part in additive manufacturing.
4. Practical simulation of a case

Intended learning outcomes:

1. To know the reason behind the revolution of additive manufacturing in manufacturing of products
2. To understand the reason which justify the consideration of additive manufacturing as one of the key enabling technologies in strategic agendas
3. To know the range of industrial technologies for additive manufacturing
4. To understand the process flow when manufacturing a product by additive manufacturing

Lecturer's references

Additive Manufacturing Materials and Technology (2024)
Elsevier - ISBN: 9780443184628

Additive Manufacturing. A Tool for Industrial Revolution 4.0 (2021)
Elsevier - ISBN: 9780128220566

Fabricación aditiva (2023)
Universidad Nacional a Distancia (UNED) – ISBN: 9788436279450

Course title:	A7. Reverse engineering and inspection in digital factory
Lecturer:	**Sara Giganto and Joaquín Barreiro**
Affiliation:	**Universidad de León**

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
1					1

Assessment methods:	Written examination

Syllabus outline:

1. What is reverse engineering and difference with inspection (5 minutes)
2. Review of technologies for reverse engineering (15 minutes)
3. Technologies for automated inspection in coordinate metrology (5 minutes)
4. Capabilities, advantages, constraints and limits of optical systems for reverse engineering and inspection (10 minutes)
5. Practical case of part reconstruction and modelling (10 minutes)

Objective competences:

5. Comprehensive overview of the different sensors for reverse engineering and coordinate based inspection.
6. Knowledge about limits and advantages of sensors.
7. Basic knowledge about the actions for preparing, scanning and post-processing a part in reverse engineering and inspection.
8. Practical simulation of a case.

Intended learning outcomes:

1. To know the map of technologies used in 3D scanning of parts.
2. To understand the working principle of optical sensors for reverse engineering or inspection in a digital factory.
3. To understand the benefits of using reverse engineering for reconstruction of parts in a competitive world-class context.
4. To understand the process steps when scanning a part for geometry modification or inspection
5. To understand the strong link between reverse engineering and additive manufacturing

Lecturer's references

3D Scanning for Advanced Manufacturing, Design, and Construction (2023)
Wiley - ISBN: 978-1119758518

Course title:	A8. Introduction to Industrial Cybersecurity
Lecturer:	**Miguel A. Prada**
Affiliation:	**Universidad de León**

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
2					**2**

Assessment methods:	Written examination

Syllabus outline:

1. Relevance of industrial cybersecurity
2. Distinctive features of industrial control systems
3. Threats, vulnerabilities and impact
4. Known incidents
5. Security measures in industrial control systems

Objective competences:

1. Awareness of cybersecurity risks in industrial control systems and critical infrastructures
2. Overview of the features of industrial control systems in contrast to traditional information systems
3. Overview of threats, vulnerabilities and countermeasures in industrial control systems

Intended learning outcomes:

1. Understand the relevance of cybersecurity in industrial control systems and critical infrastructures
2. Understand the main threats and vulnerabilities in industrial control systems in contrast to traditional information systems
3. Acquire a high-level view of procedures and measures available to mitigate cybersecurity risks.

Literature

K. Stouffer, S. Lightman, V. Pillitteri, M. Abrams & A. Hahn. NIST Special Publication 800-82 Rev. 2. Guide to Industrial Control Systems (ICS) Security https://doi.org/10.6028/NIST.SP.800-82r2

Section B. Nanotechnology

Course title:	B1. Nanomaterials: Introduction
Lecturer:	**Liliia Turovska**
Affiliation:	Vasyl Stefanyk Precarpathian National University

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
2					**2**

Assessment methods:	Written examination

Syllabus outline:

1. Nanotechnology and nanomaterials.
2. Classifications of nanomaterials, their properties.
3. Historical overview of nanomaterials.
4. Reasons for special properties of nanoscale materials.
5. Classical and quantum size effects.
6. Basic concepts of quantum physics.
7. The energy of an electron in an atom.
8. Harmonic oscillator: transition from classical to quantum theory.
9. Wave-particle duality. Uncertainty principle.
10. Condensed matter physics. Electrons in crystals.
11. Quantum dots and their applications.
12. Applications of nanomaterials.

Objective competences:

1. Overview of nanomaterials (history and properties).
2. Modern applications of nanomaterials.
3. Basic concepts of quantum physics.

Intended learning outcomes:

1. Participants will gain general knowledge about nanomaterials and their properties.
2. Participants will be able to identify different types of nanomaterials.
3. Participants will distinguish between classical and quantum size effects.
4. Participants will understand the basic concept of quantum mechanics.

Literature

1. Akkerman, Q. A. "Lead Halide Perovskite Nanocrystals: A New Age of Semiconductive Nanocrystals." 2019. http://dx.doi.org/10.13140/RG.2.2.23651.81442
2. Ali, Ali Salman. “Application of Nanomaterials in Environmental Improvement.” IntechOpen eBooks, 2020, https://doi.org/10.5772/intechopen.91438
3. Arulmani, S., et al. “Introduction to Advanced Nanomaterials.” Elsevier eBooks, 2018, pp. 1–53. https://doi.org/10.1016/b978-0-12-813731-4.00001-1
4. Findik, Fehim. “Nanomaterials and Their Applications.” Periodicals of Engineering and Natural Sciences (PEN), vol. 9, no. 3, International University of Sarajevo, June 2021, p. 62. https://doi.org/10.21533/pen.v9i3.1837
5. Kumar, Pawan, et al. “Nanostructured Materials: A Progressive Assessment and Future Direction for Energy Device Applications.” Coordination Chemistry Reviews, vol. 353, Elsevier BV, Dec. 2017, pp. 113–41. https://doi.org/10.1016/j.ccr.2017.10.005
6. Negri, Viviana, et al. “Carbon Nanotubes in Biomedicine.” Topics in Current Chemistry, vol. 378, no. 1, Springer Science+Business Media, Jan. 2020, https://doi.org/10.1007/s41061-019-0278-8
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8. Raghvendra, R., et al. "Diagnostics and therapeutic application of gold nanoparticles." International Journal of Pharmacy and Pharmaceutical Science, vol. 6, 2014, pp. 74-87
9. Sahoo, Biswa Mohan, et al. “Nanotechnology: A Novel Approach for Drug Development in Health Care System.” Current Nanomaterials, vol. 5, no. 1, June 2020, pp. 12–25. https://doi.org/10.2174/2405461505666200320152824
10. Schwabl, Franz. “Quantum Mechanics.” Springer eBooks, 2007, https://doi.org/10.1007/978-3-540-71933-5
11. Wu, Bing-Fei. “Quantum Mechanics”. 2023, https://doi.org/10.1007/978-981-19-7626-1

Lecturer's references

https://orcid.org/0000-0002-3530-7518

Course title:	B2. Nanomaterials: Magic of Carbon
Lecturer:	**Volodymyra Boichuk**
Affiliation:	Vasyl Stefanyk Precarpathian National University

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
2					2

Assessment methods:	Written examination

Syllabus outline:

13. Carbon. Allotropes.
14. Electronic structure of carbon.
15. Diamond:properties.
16. Graphite: properties.
17. Graphene:unique properties, crystal structure, production.
18. Graphene oxide and graphite oxide.
19. Obtaining graphene oxide.
20. Reduced graphene oxide.
21. Carbon nanotubes: synthesis, chirality, properties.
22. Fullerenes: synthesis,properties, application.
23. Applications of carbon nanomaterials.
24. Biochar. Porous carbon.

Objective competences:

1. Review of the main properties of allotropic modifications of carbon.
2. Graphene: unique properties and applications.
3. Methods for obtaining graphene oxide and reduced graphene oxide.
4. Overview of methods for experimental study of graphene materials.

Intended learning outcomes:

1. Participants will gain general knowledge about carbon materials.
2. Participants will distinguish between different allotropic modifications of carbon.
3. Participants will understand the various approaches to obtaining GO and rGO.
4. Participants will be able to distinguish the results of an experimental study of graphene materials.

Literature

1. Ahlawat, Jyoti, et al. “Application of Carbon Nano Onions in the Biomedical Field: Recent Advances and Challenges.” Biomaterials Science, vol. 9, no. 3, Royal Society of Chemistry (RSC), 2021, pp. 626–44. Crossref, https://doi.org/10.1039/d0bm01476a
2. Avouris, Phaedon. “Graphene: electronic and photonic properties and devices.” Nano letters vol. 10,11 (2010): 4285-94. https://doi.org/10.1021/nl102824h
3. “Carbonaceous Composite Materials.” Materials Research Foundations, 2018, https://doi.org/10.21741/9781945291975

4. "Chemistry of the Main Group Elements (Barron)." Chemistry LibreTexts, 8 Sept. 2020, https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Chemistry_of_the_Main_Group_Elements_(Barron)
5. Gao, Wei. "Graphene Oxide." Springer eBooks, 2015, https://doi.org/10.1007/978-3-319-15500-5
6. "Graphene, Nanotubes and Quantum Dots-Based Nanotechnology." Elsevier eBooks, 2022, https://doi.org/10.1016/c2020-0-01826-8
7. Hybrid Orbitals — Overview & Examples https://www.expii.com/t/hybrid-orbitals-overview-examples-8366
8. Maiti, Debabrata, et al. "Carbon-Based Nanomaterials for Biomedical Applications: A Recent Study." Frontiers in Pharmacology, vol. 9, Frontiers Media, Mar. 2019, https://doi.org/10.3389/fphar.2018.01401
9. Matsumoto, Kazuhiko. "Frontiers of Graphene and Carbon Nanotubes." Springer eBooks, 2015, https://doi.org/10.1007/978-4-431-55372-4
10. Mbayachi, V.B., et al. "Graphene Synthesis, Characterization and Its Applications: A Review." Results in Chemistry, vol. 3, Elsevier BV, Jan. 2021, p. 100163. https://doi.org/10.1016/j.rechem.2021.100163
11. Neto, A. H. Castro, et al. "The Electronic Properties of Graphene." Reviews of Modern Physics, vol. 81, no. 1, American Physical Society, Jan. 2009, pp. 109–62. https://doi.org/10.1103/revmodphys.81.109
12. Orbital Hybridization: sp1, sp2, and sp3 Hybridization, Examples https://researchtweet.com/orbital-hybridization-sp1-sp2-sp3-hybridization/
13. Patel, Dinesh Kumar, et al. "Carbon Nanotubes-Based Nanomaterials and Their Agricultural and Biotechnological Applications." Materials, vol. 13, no. 7, Multidisciplinary Digital Publishing Institute, Apr. 2020, p. 1679. https://doi.org/10.3390/ma13071679
14. Tîlmaciu, Carmen, and May Morris. "Carbon Nanotube Biosensors." Frontiers in Chemistry, vol. 3, Frontiers Media, Oct. 2015, https://doi.org/10.3389/fchem.2015.00059

Lecturer's references

https://kmint.pnu.edu.ua/en/staff/volodymyra-boichuk/

Course title:	B3. An introduction to Quantum Computing
Lecturer:	**Egon Pavlica**
Affiliation:	**University of Nova Gorica**

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
1					1

Assessment methods:	Written examination

Syllabus outline:

Participants will learn about quantum phenomena, which govern nature. These quantum phenomena will be explained through photon's interference, which will be introduced by double-slit and double-beam splitter experiments. Next, classical computation will be compared to quantum computation. Quantum bit will be introduced. Participants will learn through an example of the quantum algorithm, presented in real quantum computer and in a quantum computer simulator.

Objective competences:

1. Learn about quantum nature of photons and possibility of application in quantum computing
2. Learn about the definition of quantum bit (qubit)
3. See a tutorial on quantum programming in quantum computer or quantum computer simulator

Intended learning outcomes:

1. Understand the difference between classical and quantum computing
2. Understanding what is qubit
3. Obtain an idea of quantum computing algorithm

Literature

[1] P. Kaye, R. Laflamme, and M. Mosca, *An Introduction to Quantum Computing*, Repr (Oxford University Press, Oxford, 2010).

Lecturer's references

E. Pavlica is a professor of physics habilitated at the University of Nova Gorica. E. Pavlica is conducting a course of Programming as a part of the programm "Physics and astrophysics" at the School of Science, University of Nova Gorica.

Section C. Entrepreneurship and Innovation

Course title:	C1. Innovation on the field (real cases)
Lecturer:	**Simon Mokorel**
Affiliation:	**RRA SP**

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
1	-	-	-	-	1

Assessment methods:	Written examination

Syllabus outline:

1. From invention to innovation
2. Art & Design Thinking
3. Cases of innovation

Objective competences:

Overview and critical reflection on the main differences between invention and innovation

Intended learning outcomes:

1. Understanding how inventions become innovations
2. Reflect on real cases of innovation

Course title:	C2. Entrepreneurship and start-up management
Lecturer:	**Giancarlo Lauto**
Affiliation:	**University of Udine**

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
2					**2**

Assessment methods:	Written examination

Syllabus outline:
1. What is an entrepreneur? (Lecture) 2. Approaches to the start-up phase (Lecture) 3. The lean start-up approach in action (Hands-on)

Objective competences:
1. An overview of the features of entrepreneurial activities 2. A discussion of various approaches that individuals may adopt when they start a new venture 3. An application of the lean start-up approach to a business case

Intended learning outcomes:
1. Knowing the economic function of entrepreneurship 2. Knowing the strengths and weaknesses of different patterns to the start-up 3. Being able to apply the principles of the “lean start-up” methodology to an entrepreneurial idea

Literature
1. Ries, E. (2011). The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. Currency. 2. Eisenmann, T. R., Ries, E., & Dillard, S. (2012). Hypothesis-driven entrepreneurship: The lean startup. Harvard Business School Entrepreneurial Management Case, (812-095).

Lecturer's references
Giancarlo Lauto is an associate professor of Organization Studies at the University of Udine, where he teaches the Laboratory of cross cultural negotiation in the Master degree in International Marketing and Organization.

Course title:	C3. Business strategies in high-innovation potential areas (Nanotechnology, Industry 4.0, Artificial intelligence)
Lecturer:	Valentyna Yakubiv
Affiliation:	Vasyl Stefanyk Precarpathian National University (Ukraine)

Duration (hours)

Lectures	Seminar	Tutorial	Laboratory work	Field work	Individ. work
2	-	-	-	-	-

Assessment methods: group disscution	Written examination **No**

Syllabus outline:

This course aims to equip students with knowledge and skills in business strategy development and management process of its implementation in high-innovation potential areas (Nanotechnology, Industry 4.0, Artificial intelligence). This course focuses on strategic analysis, strategic planning, developing and implementing strategies.

Objective competences:

1. A comprehensive overview of business strategies in high-innovation potential areas (Nanotechnology, Industry 4.0, Artificial intelligence)
2. A comprehensive overview of key methods in business strategic analysis in high-innovation potential areas
3. Practical skills for business strategic analysis in high-innovation potential areas
4. Practical skills for formulating the vision, mission, objectives and road map in startups in high-innovation potential areas

Practical skills for building a business model canvas for startups in high-innovation potential areas

Intended learning outcomes:

1. Understanding the importance of business planning in the process of creating startups
2. Students will be able to perform the business strategic analysis in high-innovation potential areas.
3. Students will be able to formulate the vision, mission, objectives and road map in startups in high-innovation potential areas
4. Students will be able to build a business model canvas for startups in high-innovation potential areas.
4. Mini-Internship to get started with business strategic planning in startups in Nanotechnology, Industry 4.0, Artificial intelligence

Literature

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