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


# Report of Contributions

Contribution ID: **1** Type: **not specified**

# Digital Transformation Journey

*Friday, 12 April 2024 09:15 (45 minutes)*

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

**Presenter:** Mr BERTETTI, Massimiliano

Contribution ID: **2** Type: **not specified**

# Introduction to Machine Learning

*Friday, 12 April 2024 10:00 (1h 30m)*

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

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

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

**Presenter:** Mrs ALAIZ RODRÍGUEZ, Rocío

Contribution ID: **3** Type: **not specified**

# Machine Learning and Computer Vision in Industry 4.0: Use case 1

*Friday, 12 April 2024 12:00 (1h 30m)*

Syllabus outline:
Use pretrained Support Vector Machine (SVM) traditional model to classify steel plates. Hands-on: 120 minutes.
Visualization of a classifier trained on computer vision.
Training and test data visualization.
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:
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.
To identify the parts of an image processing system.
To know how to evaluate the performance of a machine learning model.

**Presenters:** Mrs MARTÍNEZ MENDOZA, Alicia; Mr JÁÑEZ MARTINO, Francisco

Contribution ID: **4** Type: **not specified**

# Introduction to Convolutional Neural Networks and its application in Computer Vision

*Friday, 12 April 2024 14:30 (1h 30m)*

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

**Presenter:** Mr FIDALGO FERNÁNDEZ, Eduardo

Contribution ID: **5** Type: **not specified**

# Machine Learning and Computer Vision in Industry 4.0: Use case 2

*Friday, 12 April 2024 16:30 (1h 30m)*

Syllabus outline:
Use pretrained Convolutional Neural Networks (CNNs) to classify inserts. Hands-on: 120 minutes.
Visualization of the structure of a CNN architecture.
Training and test data visualization.
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:
To classify inserts as having high or low wear using features extracted using pre-trained CNNs.
To identify the parts of an image processing system.
To know how to evaluate the performance of a machine learning model.

**Presenters:** Mrs MARTÍNEZ MENDOZA, Alicia; Mr CAROFILIS VASCO, Roberto Andrés

Contribution ID: **6** Type: **not specified**

# Additive manufacturing as a mean for supporting rapid development of innovative products

*Friday, 19 April 2024 10:00 (1h 30m)*

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:
Comprehensive overview of the different additive manufacturing technologies.
Knowledge about limits and advantages of additive processes compared to traditional manufacturing.
Basic knowledge about the actions for preparing, manufacturing and post-processing a part in additive manufacturing.
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

**Presenters:** BARREIRO GARCÍA, Joaquín (Universidad de León); Mrs PELÁEZ, Sofía

Contribution ID: **7** Type: **not specified**

# Additive manufacturing as a mean for supporting rapid development of innovative products

*Friday, 19 April 2024 12:00 (45 minutes)*

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:
Comprehensive overview of the different additive manufacturing technologies.
Knowledge about limits and advantages of additive processes compared to traditional manufacturing.
Basic knowledge about the actions for preparing, manufacturing and post-processing a part in additive manufacturing.
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

**Presenters:** BARREIRO GARCÍA, Joaquín (Universidad de León); Mrs PELÁEZ, Sofía

Contribution ID: **8** Type: **not specified**

# Reverse engineering and inspection in digital factory

*Friday, 19 April 2024 12:45 (45 minutes)*

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

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

**Presenters:** BARREIRO GARCÍA, Joaquín (Universidad de León); Mrs GIGANTO, Sara

Contribution ID: **9** Type: **not specified**

# Nanomaterials: Introduction

*Friday, 19 April 2024 14:30 (1h 30m)*

Syllabus outline:
Nanotechnology and nanomaterials.
Classifications of nanomaterials, their properties.
Historical overview of nanomaterials.
Reasons for special properties of nanoscale materials.
Classical and quantum size effects.
Basic concepts of quantum physics.
The energy of an electron in an atom.
Harmonic oscillator: transition from classical to quantum theory.
Wave-particle duality. Uncertainty principle.
Condensed matter physics. Electrons in crystals.
Quantum dots and their applications.
Applications of nanomaterials.

Objective competences:
Overview of nanomaterials (history and properties).
Modern applications of nanomaterials.
Basic concepts of quantum physics.

Intended learning outcomes:
Participants will gain general knowledge about nanomaterials and their properties.
Participants will be able to identify different types of nanomaterials.
Participants will distinguish between classical and quantum size effects.
Participants will understand the basic concept of quantum mechanics.

Literature

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
Ali, Ali Salman. "Application of Nanomaterials in Environmental Improvement." IntechOpen eBooks, 2020, https://doi.org/10.5772/intechopen.91438
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
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
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
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
O'Brien, Stephen, et al. "Synthesis of Monodisperse Nanoparticles of Barium Titanate: Toward a Generalized Strategy of Oxide Nanoparticle Synthesis." Journal of the American Chemical Society, vol. 123, no. 48, American Chemical Society, Nov. 2001, pp. 12085–86. https://doi.org/10.1021/ja011414a
Raghvendra, R., et al. "Diagnostics and therapeutic application of gold nanoparticles." International Journal of Pharmacy and Pharmaceutical Science, vol. 6, 2014, pp. 74-87
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/10.2174/2405461505666200320152
Schwabl, Franz. "Quantum Mechanics." Springer eBooks, 2007, https://doi.org/10.1007/978-3-540-

71933-5
Wu, Bing-Fei. “Quantum Mechanics”. 2023, https://doi.org/10.1007/978-981-19-7626-1

**Presenter:** Mrs TUROVSKA, Liliia

Contribution ID: **10** Type: **not specified**

# Nanomaterials: Magic of carbon

*Friday, 19 April 2024 16:30 (1h 30m)*

Syllabus outline:
Carbon. Allotropes.
Electronic structure of carbon.
Diamond:properties.
Graphite: properties.
Graphene:unique properties, crystal structure, production.
Graphene oxide and graphite oxide.
Obtaining graphene oxide.
Reduced graphene oxide.
Carbon nanotubes: synthesis, chirality, properties.
Fullerenes: synthesis,properties, application.
Applications of carbon nanomaterials.
Biochar. Porous carbon.

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

Intended learning outcomes:
Participants will gain general knowledge about carbon materials.
Participants will distinguish between different allotropic modifications of carbon.
Participants will understand the various approaches to obtaining GO and rGO.
Participants will be able to distinguish the results of an experimental study of graphene materials.
Literature

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
Avouris, Phaedon. "Graphene: electronic and photonic properties and devices." Nano letters vol. 10,11 (2010): 4285-94. https://doi.org/10.1021/nl102824h
"Carbonaceous Composite Materials." Materials Research Foundations, 2018, https://doi.org/10.21741/9781945291975
"Chemistry of the Main Group Elements (Barron)." Chemistry LibreTexts, 8 Sept. 2020, https://chem.libretexts.org/Bookshelv
Gao, Wei. "Graphene Oxide." Springer eBooks, 2015, https://doi.org/10.1007/978-3-319-15500-5
"Graphene, Nanotubes and Quantum Dots-Based Nanotechnology." Elsevier eBooks, 2022, https://doi.org/10.1016/c2020-0-01826-8
Hybrid Orbitals — Overview & Examples https://www.expii.com/t/hybrid-orbitals-overview-examples-8366
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
Matsumoto, Kazuhiko. "Frontiers of Graphene and Carbon Nanotubes." Springer eBooks, 2015, https://doi.org/10.1007/978-4-431-55372-4
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
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

Orbital Hybridization: sp1, sp2, and sp3 Hybridization, Examples https://researchtweet.com/orbital-hybridization-sp1-sp2-sp3-hybridization/
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
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

**Presenter:** Mrs BOICHUK, Volodymyra

Contribution ID: **11** Type: **not specified**

# Introduction to Industrial Cybersecurity

*Friday, 3 May 2024 10:00 (1h 30m)*

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

**Presenter:** Mr PRADA MEDRANO, Miguel Ángel

Contribution ID: **12** Type: **not specified**

# An Introduction to Quantum computing

*Friday, 3 May 2024 12:00 (45 minutes)*

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

Intended learning outcomes:
Understand the difference between classical and quantum computing
Understanding what is qubit
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).

**Presenter:** PAVLICA, Egon (UNG)

Contribution ID: **13** Type: **not specified**

# Innovation on the field (real cases)

*Friday, 3 May 2024 12:45 (45 minutes)*

Syllabus outline:
From invention to innovation
Art & Design Thinking
Cases of innovation

Objective competences:
Overview and critical reflection on the main differences between invention and innovation

Intended learning outcomes:
Understanding how inventions become innovations
Reflect on real cases of innovation

**Presenter:** Mr MOKOREL, Simon (RRA NORTH PRIMORSKA)

Contribution ID: **14** Type: **not specified**

# Entrepreneurship and start-up management

*Friday, 3 May 2024 14:30 (1h 30m)*

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).

**Presenter:** LAUTO, Giancarlo (Department of Economics and Statistics)

Contribution ID: **15** Type: **not specified**

# Business strategies in high-innovation potential areas (Nanotechnology, Industry 4.0, Artificial intelligence)

*Friday, 3 May 2024 16:30 (1h 30m)*

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:
A comprehensive overview of business strategies in high-innovation potential areas (Nanotechnology, Industry 4.0, Artificial intelligence)
A comprehensive overview of key methods in business strategic analysis in high-innovation potential areas
Practical skills for business strategic analysis in high-innovation potential areas
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

Hunsaker, B.T.; Knowles, J. Effective Innovation Begins with Strategic Direction. MIT Sloan Manag. Rev. 2021, 11. Available online: https://sloanreview.mit.edu/article/effective-innovation-begins-with-strategic-direction/.

Wolf, V.; Dobrucka, R.; Przekop, R.; Haubold, S. Innovation strategies in the context of the paradigm of the five dimensions of innovation strategy. Logforum 2021, 17, 205–211.

Gaubinger, K.; Rabl, M.; Swan, S.; Werani, T. Innovation Strategy. In Innovation and Product Management; Springer: Berlin/Heidelberg, Germany, 2015; pp. 61–80.

**Presenter:** Mrs YAKUBIV, Valentina (VASYL STEFANYK PRECARPATHIAN NATIONAL UNIVERSITY)

Contribution ID: **16** Type: **not specified**

# Welcome

*Friday, 12 April 2024 09:00 (15 minutes)*

**Presenter:** FERNÁNDEZ-ROBLES, Laura (Universidad de León)