Joint Master's in Advanced Digital Technologies for Business

MASTERS PROGRAMME FOCUSED ON THE PRACTICAL APPLICATION OF ADVANCED DIGITAL SKILLS WITHIN EUROPEAN COMPANIES (DIGITAL4BUSINESS)

Table of Contents

Preface **3**

Modules **6**

Digital Transformation 6

AI for Business 11

Data Science for Business 17

Cybersecurity for Business 22

Cloud Computing for Business 29

Business Programming 35

Internet of Things 40

Blockchain Technologies 45

Quantum Computing 51

Data Governance and Ethics 56

Innovation 62

Generative AI 68

Risk & Change Management 73

Digital Transformation Project / Practicum 78

Preface

The Joint Professional **Master's Degree in Advanced Digital Technologies for Business** has been meticulously designed and developed by the Digital4Business consortium. Funded by the European Commission with a budget of €19.92 million, Digital4Business represents a collaborative effort involving 15 partners across seven EU countries. Our mission is to nurture the next generation of digital leaders and innovators equipped with the competencies required to navigate and shape the digital transformation of businesses throughout Europe.

Educational Philosophy and Approach

At the core of DIGITAL4Business is a commitment to a competency-based educational model, merging rigorous academic standards with industry-relevant skills. This approach integrates the latest developments in curriculum design, combining theoretical knowledge and practical competencies to create a holistic learning experience.

The DIGITAL4Business Consortium has jointly worked to define the foundations of the Master's programme, reflecting a shared vision of establishing a central hub for advanced digital technology education. This collaboration unites Europe's leading higher education institutions, research centres, and industry stakeholders, underscoring our commitment to an interdisciplinary and collaborative approach to digital education.

As part of the initial phase, the Consortium ran a comprehensive Needs Analysis across Europe in order to determine the actual requirements of Advanced Digital Skills and shape up an industry-informed programme. The findings of the Consortium were published as a peer-reviewed paper and presented in AIED 2024, highly coveted conference in computing and education:

Somers, C., Feenan, D., Fitzgerald, D., Henriques, R., Martignoni, M., Parletta, D.A., Cibin, E., Chis, A.E., González-Vélez, H.: *Systematic needs analysis of advanced digital skills for postgraduate computing education: The DIGITAL4Business case*. In: AIED 2024. CCIS, vol. 2150, pp. 179–191. Springer, Recife (Jul 2024) https://doi.org/10.1007/978-3-031-64315-6_14

Four academic partners – **National College of Ireland (NCI)**, **Alma Mater Studiorum - Università di Bologna (UNIBO)**, **Linköping University (LIU)**, and **Universidade Nova de Lisboa (UNL)** – have developed the programme's core modules. These modules address in-demand digital competencies such as Artificial Intelligence, Cybersecurity, Cloud Computing, Data Science, and Digital Transformation. Elective modules include emerging technologies such as Blockchain, the Internet of Things, Generative AI, and Quantum Computing, as well as essential topics including Programming for Productivity, Data Governance and Ethics, Innovation, and Risk and Change

Management in Digital Environments. Together, these ensure graduates are well-equipped to lead in technological innovation.

Flexibility and Inclusivity

DIGITAL4Business recognises the diverse needs of its student base. The Master's programme therefore offers a flexible, modular learning platform that is accessible to individuals from various sectors and backgrounds. This inclusivity extends to a hybrid delivery model, blending online learning with in-person workshops, seminars, and networking events. Our goal is to make advanced digital education both accessible and affordable, fostering gender equality, promoting ethnic diversity, and addressing unemployment among disadvantaged groups.

Vision for the Future

DIGITAL4Business is not just a European project, but a movement aimed at bridging Europe's digital skills gap. By empowering students with the knowledge, competencies, and professional attributes needed for the digital age, the programme emphasises academic excellence, industry collaboration, and a forward-looking curriculum.

Our engagement with the European Commission and participation in key digital skills initiatives highlight our commitment to this mission. With the inaugural cohort of students set to enrol, DIGITAL4Business marks a new chapter in European digital education.

We invite you to join us in this transformative endeavour to shape the digital future of Europe.

About this Document

This handbook contains detailed module descriptors for all the modules offered in the Joint Professional Master's Degree in Advanced Digital Technologies for Business. It serves as a comprehensive guide to the programme's content, structure, and objectives.

Yours truly,

The DIGITAL4Business Consortium

Tuesday 16 June 2026

Modules

Digital Transformation

<table>
<tr><td>Module designation</td><td colspan="2">Digital Transformation</td></tr>
<tr><td>Offered as micro-credential</td><td colspan="2">Yes</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>Full Time</td><td>Semester 1 (Year 1)</td></tr>
<tr><td></td><td>Part Time Accelerated</td><td>Semester 1 (Year 1)</td></tr>
<tr><td></td><td>Part Time</td><td>Semester 1 (Year 1)</td></tr>
<tr><td>Partner responsible for the module</td><td colspan="2"><u>UNIBO</u></td></tr>
<tr><td>Person responsible for the module</td><td colspan="2">Chiara Panciroli (scientific responsibility)
Veronica Russo (organizational responsibility)</td></tr>
<tr><td>Language</td><td colspan="2">English</td></tr>
<tr><td>Relation to curriculum</td><td colspan="2">Compulsory</td></tr>
<tr><td>Teaching methods</td><td colspan="2">Teaching is fully online. The module employs an innovative hybrid learning methodology, alternating between synchronous and asynchronous activities. A tutor, both an expert in module content and a facilitator of student learning, supports students throughout. Key methods include:
Synchronous Lectures: Interactive, real-time sessions.
Asynchronous Activities: Independent study and project-based tasks archived in a digital e-portfolio.
Group Work: Laboratory exercises to foster collaborative problem-solving.
The main teaching strategies include Work-Based Learning, Problem-Based Learning, Gamification, and Flipped Classroom techniques. Emerging technologies, including Artificial Intelligence, are integrated to enhance learning experiences.</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>36</td></tr>
<tr><td>Other hours (Practical work /work-based learning)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>190</td></tr>
<tr><td>Total (hours)</td><td>250</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>10 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Basic understanding of digital technologies and organisational processes.
2. Familiarity with business operations and change management.
3. Introductory knowledge of data-driven decision-making.</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>The module aims to enable students to understand, discuss and synthesise the fundamentals of Digital Transformation and the main Digital Implementation strategies.

The Digital Transformation Module is a deep dive into the essentials of digital transformation concepts and enablers. Students will critically assess digital transformation paradigms to understand their influence on innovative business models, while defining the deployment of strategic resources for effective digital change. The course emphasises the design and implementation of cutting-edge digital transformation strategies, using practical exercises to simulate real-world applications. This module aims to equip students with the necessary skills to navigate and lead digital transformation efforts, preparing them to effectively manage and capitalise on the opportunities of the digital business landscape.

This curricular unit intends to develop methodological and research skills on business and digital transformation.

Upon successful completion of this module, learners will be able to:
LO1: Analyse and Synthesise the Key Concepts and Enablers of Digital Transformation.
LO2: Critically Evaluate Digital Transformation Paradigms and their Impact on Innovative Business Models.
LO3: Assess and Strategize the Deployment of Strategic Resources for Digital Transformation,
LO4: Design and Implement Advanced Strategies for Digital Business Transformation.</td></tr>
</table>

<table>
<tr><td>Content</td><td>Digital Transformation is a 10 ECTS module delivered over 3 hours per week for 12 weeks. Below is an indicative programme of the topics to be covered each week:

<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to Digital Transformation</td><td>Basic concepts of digital transformation. Evolution stages of digital transformation. Economic and social impacts. Digital paradigms and platform economy. Ethical issues in digital transformation. Interdisciplinary connections.</td></tr>
<tr><td>2</td><td>Technologies and Innovations</td><td>Emerging digital technologies (AI, Blockchain, IoT). Strengths and weaknesses of main digital technologies. Evolution of AI.</td></tr>
<tr><td>3</td><td>Big Data and Platform society</td><td>Platform-based business strategies. Platform economy case studies. Digital and data literacy.</td></tr>
<tr><td>4</td><td>Digital Competences</td><td>Digital competences framework. Digital communication skills and capabilities. Upskilling and reskilling.</td></tr>
<tr><td>5</td><td>Sustainable Development Goals (SDGs) framework and Digital Transformation</td><td>Ethics and sustainability in the digital age. UN SDGs. Digital projects supporting SDGs. Circular economy. KPIs for digital sustainability. CSR and social impact.</td></tr>
<tr><td>6</td><td>Digital Transformation Design: Methodologies and Tools</td><td>Industry trends in digital transformation. Tools and methodologies for organizational culture and innovation. SWOT analysis.</td></tr>
</table>
Sessions 7-12: To be detailed according to specific institutional and module requirements, potentially covering advanced topics in AI, detailed case studies in digital transformation across industries, deep dives into ethical considerations, and hands-on workshops with digital tools and methodologies.</td></tr>
</table>

<table>
<tr>
<td>Exams and assessment formats</td>
<td>Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway. Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment tools (e.g. examinations, assignments, projects, exercises) will allow direct measurement of the students' knowledge, skills, and competences.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Continuous assessment (Assessment rubrics)</td><td>Clear rubrics and grading criteria are created for each topic, indicating how students will be evaluated against the ILOs. Formative assessments can provide feedback to help students improve.</td><td>LO1, LO2, L03</td><td>60%</td><td>Ongoing</td></tr>
<tr><td>Proctored Written Test</td><td>Summative (final learning) assessment to measure students' progress at the end of the module.</td><td>L03, L04</td><td>40%</td><td>Week 8</td></tr>
</table>
</td>
</tr>
<tr>
<td>Study and examination requirements</td>
<td>Students must have an overall final grade of 40% or higher to pass this module.</td>
</tr>
</table>

Reading list	Recommended Resources • Bughin J, Catlin T, Hirt M, Willmott P. Digital transformation: Improving the odds of success. McKinsey Quarterly. 2020. • ISO/IEC 38500:2015. Governance of information technology for the organization. International Organization for Standardization. URL: http://www.iso.org/iso/catalogue_detail?csnumber=62816. • Kane GC, et al. The technology fallacy: How people are the real key to digital transformation. MIT Press; 2019. • Schmarzo B. The Economics of Data, Analytics, and Digital Transformation: The theorems, laws, and empowerments to guide your organization's digital transformation. Packt Publishing; 2020. • Siebel TM. Digital Transformation: Survive and Thrive in an Era of Mass Extinction. Rodin Books; 2019. • Westerman G, Bonnet D, McAfee A. Leading Digital: Turning Technology into Business Transformation. Harvard Business Review Press; 2014. Supplementary Resources • Christensen, CM. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Boston, MA: HBS Press, 1997. • Corazza GE, Darbellay F, Lubart T, Panciroli C. Developing Intelligence and Creativity in Education: Insights from the Space-Time Continuum. In: Creativity and Learning. London: Palgrave Macmillan; 2021. • Corazza L, Macauda A, Panciroli C, Parola A, Rivoltella PC. Audiovisual as an Atelier. Theoretical Framework and Educational Applications. In Higher Education Learning Methodologies and Technologies Online. Cham: Springer; 2023. p. 59–70. • Marr B. Artificial Intelligence in Practice: How 50 Successful Companies Used AI and Machine Learning to Solve Problems. Wiley; 2019. • Panciroli C et al. Augmented Reality in Arts Education. In: Springer Handbook of Augmented Reality. Cham: Springer; 2023. p. 305–333. • Panciroli C, Fabbri M, Macauda A. Educational Robotics between Neurosciences and Artificial Intelligence: a systematic analysis. Giorn Ital Edu Salute Sport Didatt Inclus. 2021; 5:330–339. • Schwab K. The Fourth Industrial Revolution. World Economic Forum; 2016. • Tapscott D, Tapscott A. Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World. Portfolio; 2016.

AI for Business

<table>
<tr><td>Module designation</td><td>AI for Business</td></tr>
<tr><td>Offered as micro-credential</td><td>Yes</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>
<table>
<tr><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
</table>
</td></tr>
<tr><td>Partner responsible for the module</td><td><u>LIU</u></td></tr>
<tr><td>Person responsible for the module</td><td>Fredrik Heintz
Ibrahim Delibasoglu</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Elective</td></tr>
<tr><td>Teaching methods</td><td>Teaching is fully online, blending synchronous and asynchronous activities to engage students in the theoretical and practical aspects of AI in business. The module uses innovative methods tailored to business problem-solving and enhancing digital competence.

Teaching activities include:

• Interactive Lectures: Core AI concepts are introduced through synchronous sessions featuring business scenarios and case studies to foster critical thinking and practical understanding.
• Weekly Quizzes: Formative assessments reinforce key topics, provide feedback, and measure comprehension.
• Laboratory Activities: Applied sessions with Jupyter notebooks enable hands-on coding to solve business-focused problems, enhancing technical proficiency.
• Collaborative Projects: Team-based AI solution design for business challenges promotes collaboration, teamwork, and service orientation.</td></tr>
</table>

<table>
<tr><td></td><td>

- **Problem-Based Learning and Flipped Classroom**: Pre-class resources support independent study, allowing live sessions to focus on discussions, problem-solving, and practical applications.

</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td>
<table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /work-based learning)</td><td>36</td></tr>
<tr><td>Independent learning (hours)</td><td>190</td></tr>
<tr><td>Total (hours)</td><td>250</td></tr>
</table>
</td></tr>
<tr><td>Credit points</td><td>10 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>

1. Basic knowledge of linear algebra, probability theory, and programming (preferably Python).
2. Knowledge in logic and discrete mathematics is useful.

</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>

The primary objective of this module is to provide a comprehensive understanding of the fundamental theories, methods, and models that underlie machine learning (ML) and artificial intelligence (AI). The module delves into AI and ML, focusing on their analysis, synthesis, and innovation within business contexts. Students will learn to design, train, and evaluate advanced ML models using innovative data and optimisation strategies to address real-world business challenges. Key components include rigorous performance assessment techniques, result interpretation, and effective communication of implications.

This module will equip students with the skills to innovate and improve business processes through advanced machine learning models, leading to enhanced decision-making, increased efficiency, and competitive advantage in the market. Students will also develop transferable and soft skills such as problem-solving, communication, collaboration, teamwork, and service orientation. They will apply strategic thinking to complex AI applications, critically assessing and enhancing their effectiveness in business settings.

The module addresses AI's ethical, societal, and environmental impacts, guiding students to propose responsible development and implementation practices. It prepares students to navigate the complexities of technology responsibly, ensuring that AI

</td></tr>
</table>

<table>
<tr><td></td><td>implementations are socially acceptable and environmentally sustainable, thus safeguarding organisational reputation and contributing to long-term success.

Upon successful completion of this module, learners will be able to:

LO1: Analyse, synthesise, and innovate within artificial intelligence and machine learning, emphasising critical understanding and the capability to advance the field.
LO2: Design, train, and critically evaluate advanced machine learning models, focusing on innovative data and optimisation strategies to boost performance in business applications.
LO3: Employ innovative techniques for rigorous machine learning model performance assessment, interpret results, and effectively communicate implications across various business contexts and to diverse stakeholders.
LO4: Apply strategic thinking in AI and ML for complex applications, assess effectiveness critically, propose innovative solutions or improvements, and improve problem-solving and decision-making skills.
LO5: Teamwork to develop AI solutions, enhancing collaboration skills, team competences, and service orientation towards addressing business needs.
LO6: Critically explore AI and machine learning's ethical, societal, and environmental impacts, and propose ethical, sustainable development and implementation practices within business environments.</td></tr>
<tr><td>Content</td><td>AI for Business is a 10 ECTS module delivered over 5 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:

<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to AI and its history.</td><td>Overview of AI, significance in today's world, historical development, key milestones, and introduction to AI-driven business solutions.</td></tr>
<tr><td>2</td><td>Foundational Knowledge for AI</td><td>Problem-solving, search algorithms, heuristics, adversarial search, and optimization techniques applied to business challenges. Development of analytical and problem-solving skills</td></tr>
<tr><td>3</td><td>Automated Planning</td><td>Goal achievement, decision-making, resource allocation, simulation, prediction, learning, adaptation, autonomous systems. Application</td></tr>
</table>
</td></tr>
</table>

			of automated planning to improve business workflows and operational efficiency. Collaboration on planning projects.
	4	Introduction to Machine Learning	Overview of ML, supervised/unsupervised learning, reinforcement learning, introduction to deep learning. Applying ML techniques to analyse business data. Enhancing data-driven decision-making skills.
	5	Deep Learning	Neural networks, CNNs, RNNs, deep learning applications, fostering innovation and creative thinking in developing business solutions.
	6	Data and Datasets	Importance of data, data types, data quality, pre-processing, quality datasets for business intelligence. Emphasis on teamwork in handling data projects and ensuring data integrity for AI applications.
	7	Reinforcement Learning	Basics of reinforcement learning, exploration vs. exploitation, real-world applications in business. Developing strategic thinking and problem-solving skills.
	8	Natural Language Processing (NLP)	NLP fundamentals, text processing, NLP models and techniques. Applications in sentiment analysis and customer service. Enhancing communication skills by interpreting and presenting NLP insights.
	9	Computer Vision	Basics of computer vision, image processing, object detection, challenges, and future trends. Applications in business industry and security. Collaborative projects to implement computer vision solutions.
	10	AI Tools and Platforms	Overview of AI tools/platforms, practical applications, deep learning frameworks. Selecting and integrating appropriate tools for business needs. Enhancing technical proficiency and decision-making skills.
	11	AI and creativity	AI in creative industries, design, innovation, product development, marketing strategies and prospects, industry speaker session.
	12	Ethical and Social implications in AI	Ethical challenges, societal impacts, AI bias and fairness, privacy, security. Developing ethical reasoning and responsibility in AI implementations within business environments.
Exams and assessment formats			

<table>
<tr><td></td><td>Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway.
Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment methods (e.g. laboratory assignments, projects, exercises) will allow direct measurement of the students' knowledge, skills, and competences.

<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Project</td><td>Project focusing on applying AI tools / techniques to address a business focused problem.</td><td>LO3, LO4</td><td>50%</td><td>Week 12</td></tr>
<tr><td>Proctored Written Test</td><td>Summative (final learning) assessment to measure students' progress at the end of the module.</td><td>LO1, LO2, LO5</td><td>50%</td><td>Terminal Exam</td></tr>
</table>
</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
</table>

Reading list	Recommended Resources • Du Sautoy M. The Creativity Code: Art and Innovation in the Age of AI. Harvard University Press; 2019. • Ghallab M, Nau D, Traverso P. Automated Planning: Theory & Practice. Elsevier; 2004. • Goodfellow I, Bengio Y, Courville A. Deep Learning. MIT Press; 2016. • Jurafsky D, Martin JH. Speech and Language Processing. 3rd ed. Prentice Hall; 2021. • Murphy KP. Machine Learning: A Probabilistic Perspective. MIT Press; 2012. • Russell SJ, Norvig P. Artificial intelligence: a modern approach. 4th ed. Pearson; 2020. • Sutton RS, Barto AG. Reinforcement Learning: An Introduction. 2nd ed. MIT Press; 2018. • IEEE Standards Association. Ethically Aligned Design: A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems. https://standards.ieee.org/content/ieee-standards/en/industry-connections/ec/autonomous-systems.html. Supplementary Resources • Anthes G. Artificial intelligence poised to ride a new wave. Communications of the ACM. 2017 Jul;60(7):19–21. • Gomez-Uribe CA, Hunt N. The Netflix Recommender System: Algorithms, Business Value, and Innovation. ACM Trans Manage Inf Syst. 2016 Jan;6(4): Article 13, 19 pages. • Monett D, Lewis CWP, Thórisson KR, et al. Special Issue "On Defining Artificial Intelligence" - Commentaries and Author's Response. Journal of Artificial General Intelligence. 2020 Feb;11(2). • O'Neil C. Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy. Crown; 2016. • Poole D, Mackworth A. Artificial Intelligence: Foundations of Computational Agents. 2nd ed. Cambridge University Press; 2017. • Stanley KO. Why Open-Endedness Matters. Artificial Life. 2019 Summer;25(3):232-235. • Szeliski R. Computer Vision: Algorithms and Applications. Springer; 2011. • Vaswani A, Shazeer N, Parmar N, et al. Attention is all you need. In: NIPS'17. Red Hook, NY, USA: Curran Associates Inc.; 2017. p. 6000–6010.

Data Science for Business

<table>
<tr><td>Module designation</td><td colspan="2">Data Science for Business</td></tr>
<tr><td>Offered as micro-credential</td><td colspan="2">Yes</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td></td><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td></td><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
<tr><td>Partner responsible for the module</td><td colspan="2"><u>UNL</u></td></tr>
<tr><td>Person responsible for the module</td><td colspan="2">Roberto Henriques</td></tr>
<tr><td>Language</td><td colspan="2">English</td></tr>
<tr><td>Relation to curriculum</td><td colspan="2">Elective</td></tr>
<tr><td>Teaching methods</td><td colspan="2">The module employs innovative teaching methodologies with a focus on solving real-world business problems, fostering both technical and transferable skills:
Teaching activities include:
• Hybrid Learning: A mix of synchronous (live online lectures and discussions) and asynchronous (self-paced materials, recorded lectures, and activities) formats.
• Problem-Based Learning (PBL): Students work on practical case studies and business scenarios to develop problem-solving and critical thinking skills.
• Flipped Classroom: Students review core materials independently before engaging in interactive activities.
• Collaborative Learning: Includes group-based exercises and peer reviews to promote teamwork and collaboration.</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td colspan="2"><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>36</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>36</td></tr>
<tr><td>Independent learning (hours)</td><td>178</td></tr>
<tr><td>Total (hours)</td><td>250</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td colspan="2">10 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td colspan="2">1. Basic understanding of mathematics and statistics.
2. Familiarity with spreadsheets (e.g., Excel).
3. Introductory exposure to programming concepts (optional).</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td colspan="2">This module equips students with the ability to use data science methodologies to address complex business challenges while fostering essential transferable skills such as communication, collaboration, and problem-solving.

Upon successful completion of this module, learner will be able to:

LO1: Evaluate and integrate data science principles to solve real-world business challenges, demonstrating creativity in data interpretation and insight extraction. (Transferable Skill: Critical Thinking)
LO2: Apply advanced data science methods and algorithms to develop and optimize models that address complex business problems. (Transferable Skill: Problem Solving)
LO3: Synthesize insights using statistical and machine learning techniques to make informed decisions, effectively communicating results to diverse audiences. (Transferable Skill: Communication)
LO4: Design and assess advanced visualizations, dashboards, and BI tools to deliver actionable insights and enhance business decision-making. (Transferable Skill: Service Orientation)
LO5: Collaborate within teams to design and implement data-driven solutions, fostering teamwork and adaptability. (Transferable Skill: Team Competence)</td></tr>
</table>

<table>
<tr><td>Content</td><td>Data Science for Business is a 10 ECTS module delivered over 5 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:
<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to Data Science</td><td>Overview of the data science lifecycle, focusing on how data science methodologies (e.g., CRISP-DM) help solve business challenges. Discussion of real-world case studies where data-driven decision-making led to tangible outcomes.</td></tr>
<tr><td>2</td><td>Python for Data Science</td><td>Python programming basics, data structures, packages for data analysis.</td></tr>
<tr><td>3</td><td>Data Collection and APIs</td><td>APIs, web scraping, working with unstructured data sources.</td></tr>
<tr><td>4</td><td>Databases and Data Warehousing</td><td>Introduction to relational databases and SQL. Covers ETL processes and data warehousing principles to organize and structure business-critical data for analytics.</td></tr>
<tr><td>5</td><td>Data Pre-processing and Cleaning</td><td>Handling missing data, outliers, feature encoding, normalization.</td></tr>
<tr><td>6</td><td>Exploratory Data Analysis</td><td>Use of summary statistics and visualizations to discover patterns and relationships in business data. Real-world applications in identifying customer segments and performance trends.</td></tr>
<tr><td>7</td><td>Statistical Analysis and Modelling</td><td>Statistical techniques such as regression, classification, and forecasting, tailored to solving business problems like demand forecasting and customer behaviour analysis.</td></tr>
<tr><td>8</td><td>Machine Learning</td><td>Supervised learning models (e.g., linear regression, decision trees) and their role in addressing business challenges like churn prediction and risk assessment.</td></tr>
<tr><td>9</td><td>Advanced Machine Learning Methods</td><td>Explore advanced techniques such as neural networks and deep learning. Applications in optimizing operations, personalizing customer experiences.</td></tr>
<tr><td>10</td><td>Business Intelligence and Analytics</td><td>The BI process, including data preparation, dashboard development, and predictive analytics. Real-world applications in performance monitoring and strategic decision-making.</td></tr>
<tr><td>11</td><td>Data Visualization and Dashboards</td><td>Principles of visual encodings and interactive dashboards for effective communication of data-driven insights. Applications in KPI tracking and stakeholder engagement.</td></tr>
<tr><td>12</td><td>Ethics, Bias and Privacy in Data Science and</td><td>Address ethical considerations, bias mitigation, and privacy concerns in the application of data science in business contexts. Discussion of emerging trends like</td></tr>
</table></td></tr>
</table>

		major trends in ML and DS	generative AI and explainable AI in solving business challenges.

Exams and assessment formats	The assessments are carefully designed to align with the learning outcomes and foster the development of both technical and transferable skills.
	Assessment Types:
	• Project (50%): Real-world application of data science tools/techniques to address a business-focused problem.
	  ○ LOs Addressed: LO2, LO3, LO4, LO5
	  ○ Skills Measured: Problem-solving, collaboration, and communication.
	• Proctored Written Test (50%): Summative assessment to evaluate knowledge, understanding, and application of data science in business contexts.
	  ○ LOs Addressed: LO1, LO2, LO4
	  ○ Skills Measured: Critical thinking, analytical reasoning, and ethical awareness.

Study and examination requirements	Students must have an overall final grade of 40% or higher to pass this module.
Reading list	Recommended Resources • Efron B, Hastie T. Computer Age Statistical Inference: Algorithms, Evidence, and Data Science. Cambridge: Cambridge Univ. Press; 2016. • Géron A. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media; 2019. • Hand DJ, Mannila H, Smyth P. Principles of Data Mining (Adaptive Computation and Machine Learning). MIT Press; 2001. • Hastie T, Tibshirani R, Friedman J. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition. New York: Springer; 2009. • Leskovec J, Rajaraman A, Ullman JD. Mining of Massive Datasets, 3rd Edition. Cambridge: Cambridge University Press; 2020. • Wasserman L. All of Statistics: A Concise Course in Statistical Inference. New York: Springer; 2004. Supplementary Resources • Abbott D. Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst. Wiley; 2014.

	• Alloghani M, Al-Jumeily D, Mustafina J, et al. A Systematic Review on Supervised and Unsupervised Machine Learning Algorithms for Data Science. Springer, Cham; 2020. • Georgieva I, Lazo C, Timan T et al. From AI ethics principles to data science practice: a reflection and a gap analysis based on recent frameworks and practical experience. AI Ethics. 2022; 2:697–711. • James G, Witten D, Hastie T, Tibshirani R. An Introduction to Statistical Learning: with Applications in R. New York: Springer; 2013. • Niu Y, Ying L, Yang J, Bao M, Sivaparthipan CB. Organizational business intelligence and decision making using big data analytics. Information Processing & Management. 2021;58(6):102725. • Provost F, Fawcett T. Data Science and its Relationship to Big Data and Data-Driven Decision Making. Big Data. 2013;1(1):51-59. • Sarker IH, Kayes ASM, Badsha S et al. Cybersecurity data science: an overview from machine learning perspective. J Big Data. 2020; 7:41. • Waller MA, Fawcett SE. Data Science, Predictive Analytics, and Big Data: A Revolution That Will Transform Supply Chain Design and Management. J Bus Logist. 2013;34(2):77-84. • Wilkerson MH, Polman JL. Situating Data Science: Exploring How Relationships to Data Shape Learning. J Learn Sci. 2020;29(1):1–10. • Yu B. Veridical Data Science. In Proceedings of the 13th International Conference on Web Search and Data Mining (WSDM '20). ACM, New York, NY, USA; 2020. p. 4–5.

Cybersecurity for Business

Module designation	Cybersecurity for Business
Offered as micro-credential	Yes
Semester(s) in which the module is taught	Full Time: Semester 1, Semester 2 (Year 1) Part Time Accelerated: Semester 1, Semester 2, Semester 3 (Year 1) Part Time: Semester 1, Semester 2 (Year 1); Semester 1, Semester 2 (Year 2)
Partner responsible for the module	**LIU**
Person responsible for the module	Mikael Asplund
Language	English
Relation to curriculum	Elective

<table>
<tr><td>Teaching methods</td><td>Teaching is fully online, blending synchronous and asynchronous activities, engaging students in both theoretical and practical aspects of cybersecurity. The module leverages innovative teaching methodologies tailored to solving cybersecurity issues in business and enhancing digital competence.

Teaching activities include:

• Interactive Lectures: Core cybersecurity concepts are introduced through synchronous sessions featuring real-world scenarios and business case studies to foster critical thinking and practical understanding.
• Weekly Quizzes: Formative assessments reinforce key topics, provide feedback, and measure comprehension.
• Laboratory Activities: Interactive sessions enable hands-on experience in identifying vulnerabilities and simulating security breaches, enhancing technical proficiency in cybersecurity problem-solving.
• Collaborative Project: Team-based cybersecurity risk management promotes collaboration, teamwork, and service orientation towards protecting organisational data.</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>36</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>190</td></tr>
<tr><td>Total (hours)</td><td>250</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>10 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Familiarity with basic programming skills,
2. Basic understanding of computer systems, business processes, and risk management</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>The module aims to enable learners to explore the field of cybersecurity. It focuses on identifying and mitigating security breaches in personal and organisational data systems.

Students will learn to identify and assess vulnerabilities in data systems, understanding how these can lead to security breaches in business environments. The course will equip students with the skills to create strong protection strategies, ensuring that data remains safe from potential threats. In addition, the module will delve into the legal and ethical dimensions of cybersecurity. Students will also develop</td></tr>
</table>

<table>
<tr>
<td></td>
<td>transferable and soft skills such as problem-solving, communication, collaboration, teamwork, and service orientation. They will apply strategic thinking to complex cybersecurity applications, critically assessing and enhancing their effectiveness in business settings.

Upon successful completion of this module, learners will be able to:

LO1: Analyse and critically evaluate vulnerabilities in personal and organisational data systems to identify potential security breaches and suggest mitigative strategies, fostering analytical thinking and attention to detail.
LO2: Synthesise and apply advanced concepts and techniques of cyber-attacks to simulate potential security breaches, demonstrating a comprehensive understanding of cyber threat landscapes and training problem-solving abilities and decision-making skills.
LO3: Design and implement robust strategies for the protection of personal and organisational data, utilising encryption techniques and security protocols to mitigate potential threats.
LO4: Evaluate and integrate tools and methodologies for the prevention and detection of cyber-attack incidents, developing critical thinking skills and demonstrating an ability to anticipate and counteract emerging cyber threats.
LO5: Critically assess and debate cybersecurity legal and ethical issues, formulating well-justified recommendations for policy and practice that reflect an advanced understanding of the complexities and responsibilities in the field of cybersecurity, developing adaptability and continuous learning habits in a rapidly evolving field.</td>
</tr>
<tr>
<td>Content</td>
<td>Cybersecurity for Business is a 10 ECTS module delivered over 5 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:

<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to Cybersecurity.</td><td>Overview of cybersecurity, its importance, and the growing demand for professionals. Understanding online identity, data, and their significance to cybercriminals. Seminar on real-world cybersecurity challenges.</td></tr>
<tr><td>2</td><td>Risk Management and Compliance</td><td>Exploring the significance of safeguarding electronic information networks and data.

Regulatory compliance requirements for business. Implementing risk assessments and</td></tr>
</table>
</td>
</tr>
</table>

			developing risk mitigation strategies: Lab on security breach case studies.
	3	Network security for Business	Addressing software and hardware vulnerabilities, device, network, and cloud security. Implementing secure network infrastructure including best practices for securing wireless networks and remote access. Lab on securing the application landscape, incident response planning and security incidents management.
	4	Cyber Attacks: Concepts and Techniques	Analysis of cyberattacks, identifying and classifying security vulnerabilities. Understanding endpoint security challenges in business environments. Securing IoT devices and other connected endpoints in business networks Seminar on vulnerabilities and real-world use cases.
	5	Data and Privacy Protection	Best practices for protecting computer devices, wireless networks, and online accounts. Implementing cryptographic methods for business data. Exploration of ethical implications and considerations in using AI and cryptography for data privacy protection. Practical exercises on implementing cryptographic techniques for privacy-preserving data sharing and analysis. Lab on data encryption and backup strategies.
	6	Organisational protection and cloud security for business	Techniques for firewall configuration, port scanning, and certificate updates. Securing cloud services and data storage in public, private, and hybrid cloud environments. Identity and access management in the cloud. Data backup and disaster recovery planning for cloud-based systems. Lab on using tools for security monitoring.
	7	Cyberattack Detection and Cyberdefense	Real-time attack detection, best security practices, and understanding botnets and the kill chain. Lab on behaviour-based security.
	8	Tools for incident	Overview of CSIRT, security playbooks, IDS, and IPS

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>prevention and detection</td><td></td></tr>
<tr><td>9</td><td>Cybersecurity Legal Issues</td><td>Personal legal issues. Corporate Legal Issues International Law and Cybersecurity</td></tr>
<tr><td>10</td><td>Ethical Issues in Cybersecurity</td><td>Overview of cybersecurity laws, regulations, and industry standards applicable to businesses. Understanding ethical considerations in cybersecurity decision-making. Addressing legal and ethical challenges related to incident response, data breaches, and privacy violations. Discussion on ethical considerations and the role of professional organisations in cybersecurity ethics.</td></tr>
<tr><td>11</td><td>Cyberwarfare</td><td>Understanding cyberwarfare, its objectives, and impacts.</td></tr>
<tr><td>12</td><td>Emerging Topics and Careers in Cybersecurity</td><td>Exploration of AI in cyberattacks and defence, the geopolitical aspects of cyberspace, and blockchain technology</td></tr>
</table>
</td></tr>
<tr><td>Exams and assessment formats</td><td>Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway. Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment tools (e.g. examinations, assignments, projects, exercises, hackathon, papers reviews) will allow direct measurement of the students' knowledge, skills and competences.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td><table>
<tr><td>Project</td><td>Project focusing on cybersecurity risk management related to business focused problems.</td><td>LO1, LO3, LO5</td><td>30%</td><td>Week 6 and 12</td></tr>
<tr><td>Proctored Written Test</td><td>Summative (final learning) assessment to measure students' progress at the end of the module.</td><td>LO1, LO3, LO5</td><td>30%</td><td>Terminal Exam</td></tr>
<tr><td>Laboratory exercises</td><td>Laboratory exercises in cybersecurity training environment</td><td>LO2, LO4</td><td>40%</td><td>Throughout course</td></tr>
</table></td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
<tr><td>Reading list</td><td><u>Recommended Resources</u>
Bishop M. Computer Security: Art and Science. 2nd ed. Boston: Addison-Wesley; 2018.
Bodmer M, Kilger M, Carpenter G, Jones J. Reverse Deception: Organized Cyber Threat Counter-Exploitation. McGraw-Hill; 2012.
Casey E. Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet. 3rd ed. Academic Press; 2011.
Information Systems Security Association. ISSA Code of Ethics. Information Systems Security Association;2023. Available from: https://www.issa.org/issa-code-of-ethics/
Kim G, Spafford G, Kerner SM. The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win. IT Revolution Press; 2018.
NIST. The NIST Cybersecurity Framework (CSF) 2.0. National Institute of Standards and Technology; 2024. Available from: https://www.nist.gov/cyberframework.
Quinn B. Data Protection Implementation Guide: A Legal, Risk and Technology Framework for the GDPR. Alphen aan den Rijn: Wolters Kluwer; 2021.
Spinello RA. Cyberethics: Morality and Law in Cyberspace. 7th ed. Burlington: Jones & Bartlett Learning; 2020.
</td></tr>
</table>

	• Stallings W, Brown L. Computer Security: Principles and Practice. 4th ed. Pearson; 2018. Recommended certification ISO 27001: information system security certification Supplementary Resources • ENISA. Threat Landscape Report. [Internet]. European Union Agency for Cybersecurity; 2024 Available from: https://www.enisa.europa.eu/topics/cyber-threats/threats-and-trends • Meeuwisse R. Cybersecurity for Beginners. 2nd ed. Cyber Simplicity Ltd; 2017. • Owens J, Griffiths P. The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations. IT Revolution Press; 2016. • Sarker IH, Kayes ASM, Badsha S, et al. Cybersecurity data science: an overview from machine learning perspective. J Big Data. 2020; 7:41. • Stallings W. Information Privacy Engineering and Privacy by Design: Understanding Privacy Threats, Technology, and Regulations Based on Standards and Best Practices. 1st ed. Boston: Addison-Wesley Professional; 2019.

Cloud Computing for Business

<table>
<tr><td>Module designation</td><td>Cloud Computing for Business</td></tr>
<tr><td>Offered as micro-credential</td><td>Yes</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>
<table>
<tr><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
</table>
</td></tr>
<tr><td>Partner responsible for the module</td><td><u>NCI</u></td></tr>
<tr><td>Person responsible for the module</td><td>Adriana E. Chis</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Elective</td></tr>
<tr><td>Teaching methods</td><td>The teaching methodology for this module will include the following approaches:
Hybrid Learning: A combination of accessible synchronous (e.g., live online lectures and discussions) and asynchronous (e.g., video lectures, case studies, individual study activities) content.
Problem-Based Learning: Students work on practical case studies and business scenarios with a focus on driving digital business transformation in a cloud-enabled business context.
Laboratory activities: Develop proposals for concrete business problems/scenarios for the adoption of cloud computing solutions within an organisation.
Flipped Classroom: First, students study independently teaching materials and/or video content prior to attending the synchronous live classes. Next, during live classes time will be allocated to discussions, practical exercises, and group work.</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>36</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>190</td></tr>
<tr><td>Total (hours)</td><td>250</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>10 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Analytical thinking and problem-solving skills
2. Basic understanding of digital technologies, organizational processes, and business operations</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>The Cloud Computing for Business module aims to provide a comprehensive coverage of Cloud Computing technologies and addresses the potential impact, challenges, and benefits of these technologies in the context of digital business transformation. Students will explore the essentials of Cloud Computing and its role in digital business transformation, assessing core principles, frameworks, and methodologies, along with the tools necessary for implementing Cloud Computing solutions effectively.
The module will touch upon governance and security challenges of cloud-based systems, guiding students to identify and evaluate various cloud security architectures and deployment strategies. The module also covers a broad spectrum of existing and emerging cloud services, including storage, machine learning, compute, analytics, and quantum computing. Students will learn to critically appraise these services and develop strategies to harness their potential for driving digital business transformation, equipping them with the knowledge to make informed decisions in a cloud-enabled business landscape.

Upon successful completion of this module, learners will be able to:
LO1: Assess core principles, frameworks, development methodologies and tools for the adoption of Cloud Computing solutions to support and enable digital business transformation.
LO2: Critically analyse the governance and security challenges associated with cloud-based systems to identify and evaluate candidate cloud security architectures and deployment strategies.
LO3: Evaluate and assess the intersection and impact of Fog and Edge Computing in relation to Cloud Computing.</td></tr>
</table>

	LO4: Critically appraise the wide range of existing and emerging cloud services (e.g., storage, machine learning, compute, analytics, quantum computing, etc.) and develop strategies to leverage such services for digital business transformation.

<table>
<tr><td>Content</td><td>Cloud Computing for Business is a 10 ECTS module delivered over 5 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:
<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Cloud Computing Introduction</td><td>Foundations. Defining Cloud Computing. Service Models. Deployment Models Cloud Technologies.</td></tr>
<tr><td>2</td><td>Enterprise Digital Architecture & Digital Transformation</td><td>Enterprise Systems Architecture. Functional/Non-functional architectural requirements. Information & Applications. Opportunities/Challenges. Business Model Innovation. Digital Transformation as a staged process. Business Readiness.</td></tr>
<tr><td>3</td><td>Cloud Strategy for Digital Transformation</td><td>Alignment with Business Goals. Key Performance Indicators (KPIs). Service Level Agreements (SLAs). Innovation. Enterprise Architecture on the Cloud. Performance. Interoperability. Scalability. Availability. Mobility. Analyticity. Usability.</td></tr>
<tr><td>4</td><td>Cloud Adoption</td><td>Cloud Adoption Frameworks. Organisational Change Management. Migration Scenarios. Hybrid Model. DevSecOps.</td></tr>
<tr><td>5</td><td>Cloud Security I</td><td>Cloud Security Concepts. Infrastructure as a Service (IaaS)/ Platform as a Service (PaaS)/ Software as a Service (SaaS) Security. Identity and Access Management (IAM).</td></tr>
<tr><td>6</td><td>Cloud Security II</td><td>Intrusion Detection/Incident Response. Encryption/Key Management Service (KMS). Disaster Recovery/Business Continuity.</td></tr>
<tr><td>7</td><td>Cloud Native</td><td>Cloud Native concepts. Architectural Considerations. Microservices/Events/Streams/Application Programming Interfaces (APIs)/Data. Impact on development / deployment. Impact on organisational structures / processes. Context-specific Patterns. Automation & Orchestration.</td></tr>
<tr><td>8</td><td>Capacity Assessment & Optimisation</td><td>Resource Utilisation. Information Lifecycle Management. Elasticity. Economic Considerations.</td></tr>
<tr><td>9</td><td>Scope of Cloud Services</td><td>Scope of Cloud Service Offerings. Data Services. Big Data Analytics. AI & ML Services. Internet of Things (IoT) Services. Quantum Computing Services.</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>10</td><td>Fog & Edge Computing</td><td>Architectural approaches to IoT and Edge Computing. Fog and Edge Architectures, (e.g., OpenFog Reference Architecture). Network Function Virtualization (NFV). Software Defined Networking (SDN). Recommendations of the National Institute of Standards and Technology (NIST).</td></tr>
<tr><td>11</td><td>Cloud Governance</td><td>Data Protection & Privacy on the cloud. Regulatory Compliance & Legal Aspects.</td></tr>
<tr><td>12</td><td>Emerging Topics in Cloud Computing</td><td>State-of-the-art research. Contemporary focus on Cloud Computing.</td></tr>
</table>
</td></tr>
<tr><td>Exams and assessment formats</td><td>Both formative (ongoing) and summative (final) assessments will be employed in the module to enable and to measure students' progress respectively. Formative assessments can provide feedback to enable students to improve their overall study pathway.
The assessments are carefully designed to cover and to evaluate the module's learning outcomes and to foster the development of both technical and transferable skills. The summative assessment will address all the module's learning outcomes and will evaluate the students' knowledge, skills, and competences. Clear assessment rubric and criteria will be created, indicating how students will be assessed against attainment of learning objectives.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Project</td><td>Project focusing on developing a strategy and business case for the adoption of cloud computing solutions within an organisation.</td><td>LO1, LO2, LO3, LO4.</td><td>100%</td><td>Week 12</td></tr>
</table>
</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
<tr><td>Reading list</td><td>Recommended Resources</td></tr>
</table>

	• Comer D. The Cloud Computing Book: The Future of Computing Explained. 1st ed. Boca Raton: Chapman and Hall/CRC; 2023. • Dotson C. Practical Cloud Security: A Guide for Secure Design and Deployment. 2nd ed. O'Reilly Media; 2023. • Faynberg I, Lu H-L, Skuler D. Cloud Computing: Business Trends and Technologies. 1st ed. Hoboken: Wiley; 2016. • Gregor H, Woolf B. Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions. 1st ed. Boston: Addison-Wesley; 2003. • Hwang K. Cloud Computing for Machine Learning and Cognitive Applications. Cambridge: The MIT Press; 2017. • Linthicum D. An Insider's Guide to Cloud Computing. 1st ed. Boston: Addison-Wesley Professional; 2023. • Marinescu DC. Cloud Computing: Theory and Practice. 3rd ed. San Diego: Morgan Kaufmann; 2022. • Millard C, editor. Cloud Computing Law. 2nd ed. Oxford: Oxford University Press; 2021. Supplementary Resources • Armbrust M, et al. Above the Clouds: A Berkeley View of Cloud Computing. EECS Department, University of California, Berkeley, Technical Report No. UCB/EECS-2009-28; 2009 Available from: http://www2.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.pdf • Buyya R, et al. A Manifesto for Future Generation Cloud Computing: Research Directions for the Next Decade. ACM Comput. Surv. 2019;51(5): 105:1-105:38. • Cao K, Liu Y, Meng G, Sun Q. An Overview on Edge Computing Research. IEEE Access. 2020; 8:85714-85728. • Baldini I, et al. Serverless Computing: Current Trends and Open Problems, In: Chaudhary S., Somani G., Buyya R. (eds) Research Advances in Cloud Computing. Springer, Singapore. 2017. Available from: https://link.springer.com/chapter/10.1007/978-981-10-5026-8_1 • Castro P, Ishakian V, Muthusamy V, Slominski A. The Rise of Serverless Computing. Comm. ACM. 2019;62(12):44-54. • Govind H, González-Vélez H. Benchmarking Serverless Workloads on Kubernetes. CCGRID 2021;704-712. • Jonas E, et al. Cloud Programming Simplified: A Berkeley View on Serverless Computing. Technical Report No. UCB/EECS-2019-3; 2019. Available from: https://www2.eecs.berkeley.edu/Pubs/TechRpts/2019/EECS-2019-3.html • Mao Y, You C, Zhang J, Huang K, Letaief KB. A Survey on Mobile Edge Computing: The Communication Perspective. IEEE Communications Surveys & Tutorials. 2017;19(4):2322-2358.

Business Programming

<table>
<tr><td>Module designation</td><td>Business Programming</td></tr>
<tr><td>Offered as micro-credential</td><td>No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>
<table>
<tr><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
</table>
</td></tr>
<tr><td>Partner responsible for the module</td><td><u>UNL</u></td></tr>
<tr><td>Person responsible for the module</td><td>Américo Rio</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Elective</td></tr>
<tr><td>Teaching methods</td><td>The module employs teaching strategies designed to develop programming expertise for solving business challenges and fostering transferable skills:
Lectures (Synchronous): Cover foundational programming concepts and their relevance to solving business problems. Delivered live to allow real-time Q&A and interaction.
Case Study Analysis: In-depth examination of real-world programming applications in business, emphasizing problem-solving and critical thinking.
Flipped Classroom Approach: Pre-class materials (videos, readings, coding tutorials) prepare students for interactive and practical in-class activities.
Project-Based Learning: Students work collaboratively on projects to design and implement programming-based solutions for business problems.</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>77</td></tr>
<tr><td>Total (hours)</td><td>125</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Familiarity with basic computer usage and general office software tools (e.g., Excel, Word).
2. Logical thinking and problem-solving interest, particularly in structured and process-oriented tasks.
3. Curiosity about technology and its role in solving business challenges, with no prior programming experience required.</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>This module equips students with practical programming skills to solve real-world business challenges, emphasizing innovative methodologies, collaboration, and problem-solving.

Upon successful completion of the module, learners will be able to:
LO1: Evaluate programming fundamentals, paradigms, and languages to devise innovative approaches for solving business-specific challenges and developing data-driven business models. (Transferable Skills: Critical Thinking, Problem Solving)
LO2: Design and implement web and mobile applications using low-code/no-code strategies to innovate business operations and models. (Transferable Skills: Creativity, Analytical Skills)
LO3: Demonstrate leadership in managing software projects, applying debugging, testing, and version control techniques to ensure quality in business programming. (Transferable Skills: Leadership, Teamwork)
LO4: Integrate data science and machine learning techniques into business programming to predict and address business challenges through automation and data insights. (Transferable Skills: Analytical Thinking, Service Orientation)
LO5: Analyse programming case studies to critique their effectiveness in solving business challenges and anticipate trends in programming for business innovation. (Transferable Skills: Communication, Critical Thinking)</td></tr>
</table>

<table>
<tr><td>Content</td><td>Business Programming is a 5 ECTS module delivered over 5 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:
<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to Programming Concepts</td><td>Basics of programming including algorithms, data structures, and problem-solving techniques. Foundation of software development for business applications.</td></tr>
<tr><td>2</td><td>Programming Paradigms and Languages</td><td>Examination of different programming paradigms (procedural, object-oriented, functional) and languages. Discussion on selecting appropriate languages for business use cases, such as financial modelling or CRM systems.</td></tr>
<tr><td>3</td><td>Business Model Development Using Programming</td><td>Techniques for developing business models through programming. Includes custom software solutions, automation, and leveraging data for decision-making.</td></tr>
<tr><td>4</td><td>Web Development for Business</td><td>Fundamentals of web development focusing on HTML, CSS, and JavaScript. Overview of both front-end and back-end development to create web applications for businesses.</td></tr>
<tr><td>5</td><td>Software Development Methodologies</td><td>Overview of Agile, Scrum, and Waterfall methodologies. Importance of project management and best practices in developing business software.</td></tr>
<tr><td>6</td><td>Introduction to Low-Code and No-Code Platforms</td><td>Exploring low-code and no-code development platforms, highlighting their benefits and business use cases.</td></tr>
<tr><td>7</td><td>Advanced Low-Code and No-Code Development</td><td>Deep dive into visual development environments and how they enable rapid application development with minimal coding.</td></tr>
<tr><td>8</td><td>Debugging and Testing Business Applications</td><td>Techniques and tools for debugging and testing. Includes unit testing, integration testing, and test-driven development tailored for business applications.</td></tr>
<tr><td>9</td><td>Version Control and Collaboration</td><td>Importance of version control (e.g., Git) in software development. Collaboration tools and techniques for team-based projects.</td></tr>
<tr><td>10</td><td>Mobile App Development for Business</td><td>Overview of approaches to mobile app development (native, hybrid, cross-platform). Tools and frameworks like React Native and Flutter for creating business applications.</td></tr>
<tr><td>11</td><td>Automating Business Processes</td><td>Utilizing programming for business process automation. Covers APIs, web scraping, and robotic process automation (RPA).</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td><table>
<tr><td></td><td>through Programming</td><td></td></tr>
<tr><td>12</td><td>Case Studies and Future Trends</td><td>Discussion of real-world case studies in business model development through programming. Future trends including AI and quantum computing's impact on business.</td></tr>
</table></td></tr>
<tr><td>Exams and assessment formats</td><td>The assessments align with learning outcomes and focus on measuring both technical and transferable skills.
Assessment Types:
Project (60%): Collaborative project to design and implement a programming-based solution addressing a business challenge.
LOs Addressed: LO2, LO3, LO4
Skills: Problem-solving, teamwork, communication, and technical skills.
Proctored Written Test (40%): Summative assessment evaluating knowledge of programming methodologies and their application in business.
LOs Addressed: LO1, LO4, LO5
Skills: Analytical Thinking, Critical Thinking</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
<tr><td>Reading list</td><td><u>Recommended Resources</u>
Abelson H, Sussman GJ, Sussman J. Structure and interpretation of computer programs. 2nd ed. Cambridge (MA): MIT Press; 1996.
Cormen TH, Leiserson CE. Introduction to Algorithms. 4th ed. MIT Press; 2022.
Downey AB. Think Python: How to Think Like a Computer Scientist. 3rd ed. O'Reilly Media; 2024.
Fowler M. Refactoring: Improving the design of existing code. Reading (MA): Addison-Wesley Professional; 1999.
Gamma E, Helm R, Johnson R, Vlissides J. Design patterns: Elements of reusable object-oriented software. Reading (MA): Addison-Wesley Professional; 1994.
Guttag JV. Introduction to Computation and Programming Using Python, third edition: With Application to Computational Modeling and Understanding Data. 3rd ed. Cambridge: The MIT Press; 2021.
Hahn J. Low Code No Code: Principles and Practices of Rapid Application Development. Apress; 2021.
Martin RC. Clean code: A handbook of agile software craftsmanship. Upper Saddle River (NJ): Prentice Hall; 2008.</td></tr>
</table>

	• McKinney W. Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. 2nd ed. Sebastopol (CA): O'Reilly Media; 2017. • Myers GJ, Sandler C, Badgett T. The Art of Software Testing. 3rd ed. Wiley; 2011. • Schwaber K, Sutherland J. The Scrum Guide: The Definitive Guide to Scrum: The Rules of the Game. Scrum.org; 2020. • Thomas D, Hunt A. The Pragmatic Programmer: Your journey to mastery, 20th Anniversary Edition. 2nd ed. Addison-Wesley; 2019. • Zelle JM. Python Programming: An Introduction to Computer Science, Fourth Edition. 4th ed. Wilsonville: Franklin, Beedle & Associates; 2024. Supplementary Resources • Bentley J. Programming Pearls. 2nd ed. Addison-Wesley; 1999. • Brooks Jr. F. The Mythical Man-Month: Essays on Software Engineering, Anniversary Edition. 2nd ed. Addison-Wesley; 1995. • Becker BA, et al. Programming Is Hard - Or at Least It Used to Be: Educational Opportunities and Challenges of AI Code Generation. In: SIGCSE 2023. USA: ACM; 2023. p. 500–506. • Chacon S, Straub B. Pro Git. 2nd ed. Apress; 2014. • Cohn M. Agile estimating and planning. Upper Saddle River (NJ): Prentice Hall; 2005. • Evans E. Domain-driven design: Tackling complexity in the heart of software. Boston (MA): Addison-Wesley Professional; 2003. • Gyasi-Agyei A. Quantum Computing for Everyone. MIT Press; 2019. • Hunt A, Thomas D. The pragmatic programmer: Your journey to mastery. Boston (MA): Addison-Wesley Professional; 1999. • Jalil S, et al. ChatGPT and Software Testing Education: Promises & Perils. 2023 ICSTW. Dublin: IEEE; 2023. p. 4130-4137. • Majekodunmi D. Business process automation with ProcessMaker 3.1: A beginner's guide. Birmingham: Packt Publishing; 2017. • Noring J. Mobile Development with React Native: Build Native Mobile Apps with JavaScript. O'Reilly Media; 2017. • Poppendieck M, Poppendieck T. Lean software development: An agile toolkit. Boston (MA): Addison-Wesley Professional; 2003. • Sarsa S, Denny P, Hellas A, Leinonen J. Automatic Generation of Programming Exercises and Code Explanations Using Large Language Models. In: ICER '22, Vol. 1. USA: ACM; 2022. p. 27–43. • Robbins J. Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics. 5th ed. O'Reilly Media; 2018. • Russell R. Do More with SOAR: Security Orchestration, Automation, and Response. Wiley; 2020. • Warden P. Practical Deep Learning for Coders. O'Reilly Media; 2021.

Internet of Things

<table>
<tr><td>Module designation</td><td>Internet of Things</td></tr>
<tr><td>Offered as micro-credential</td><td>No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>
<table>
<tr><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
</table>
</td></tr>
<tr><td>Partner responsible for the module</td><td><u>NCI</u></td></tr>
<tr><td>Person responsible for the module</td><td>Luis Bernardo Pulido-Gaytan</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Elective</td></tr>
<tr><td>Teaching methods</td><td>The module employs blended learning methodologies, incorporating both synchronous and asynchronous components to foster engagement and active learning. The teaching methods include:
Lectures and Guest Lectures: Delivered online by IoT experts, focusing on real-world IoT applications in business contexts.
Problem-Based Learning: Students work in teams to solve real-life IoT business problems, applying methodologies such as Design Thinking.
Case Study Analysis: Students critically analyse IoT implementations in various industries, fostering analytical and evaluative skills.
Flipped Classroom Approach: Pre-class resources, including readings and recorded lectures, are provided to enable deeper in-class discussions.
Workshops and Seminars: Focused sessions on IoT platforms and protocols, enabling hands-on experience with IoT devices and systems.
Collaborative Projects: Team-based IoT projects to enhance teamwork, collaboration, and service orientation skills.</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>77</td></tr>
<tr><td>Total (hours)</td><td>125</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Basic knowledge of networking and communication protocols.
2. Familiarity with programming (preferably Python or C).
3. Introductory knowledge of data analysis and business processes.</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>The Internet of Things module curriculum aims to provide learners with a comprehensive understanding of IoT fundamentals, applications, and their impact on business model development. The objectives include gaining knowledge of IoT architecture, communication protocols, devices, and data management techniques, as well as exploring IoT connectivity options, security, and risk management. Additionally, learners will develop skills in IoT project management and analyse real-world IoT case studies in business model development.

Upon successful completion of this module, learners will be able to:
LO1: Critically analyse IoT architectures and protocols, identifying their suitability for different business applications.
LO2: Design and develop IoT solutions to address specific business challenges, integrating hardware, software, and network components.
LO3: Evaluate the performance and scalability of IoT systems in real-world business scenarios, proposing improvements. Apply IoT data analytics techniques to derive actionable insights for business decision-making.
LO4: Collaborate effectively in teams to develop IoT solutions, enhancing team competences and communication skills.</td></tr>
</table>

<table>
<tr><td>Content</td><td>Internet of Things is a 5 ECTS module delivered over 3 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:
<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>IoT Fundamentals for Business</td><td>• Historical development, key concepts, applications across industries.</td></tr>
<tr><td>2</td><td>IoT Business Models and Strategies</td><td>• Value creation, monetization, competitive advantage, case studies.</td></tr>
<tr><td>3</td><td>IoT Architecture and Protocols</td><td>• Components, communication protocols, data management.</td></tr>
<tr><td>4</td><td>IoT Devices and Sensors</td><td>• Functions, applications, types of sensors., and motion sensors.</td></tr>
<tr><td>5</td><td>IoT Connectivity and Networking</td><td>• Connectivity options, networking technologies, challenges.</td></tr>
<tr><td>6</td><td>IoT Security and Privacy in Business</td><td>• Security concerns, mitigation strategies, business implications.</td></tr>
<tr><td>7</td><td>IoT Data Analytics for Business</td><td>• Data processing, storage, analysis techniques, tools, and platforms.</td></tr>
<tr><td>8</td><td>IoT Cloud Computing for Business</td><td>• Cloud-based IoT platforms, services, benefits, and challenges.</td></tr>
<tr><td>9</td><td>IoT Edge Computing for Business</td><td>• Benefits, challenges, use cases, fog computing.</td></tr>
<tr><td>10</td><td>IoT Project Management for Business</td><td>• Principles, practices, methodologies, risk management.</td></tr>
<tr><td>11</td><td>IoT Standards and Regulations for Business</td><td>• Industry standards, data protection, compliance.</td></tr>
<tr><td>12</td><td>IoT Business Model Development Case Studies and Future Trends</td><td>• Case studies, future trends, impact of emerging technologies such as AI and quantum computing.</td></tr>
</table></td></tr>
<tr><td>Exams and assessment formats</td><td>Both formative (ongoing) and summative (final) assessments will be implemented to measure student progress, focusing on their ability to apply IoT knowledge to real-world business scenarios. The assessments are directly linked to the intended learning outcomes and evaluate students' skills in analysing, designing, and developing IoT solutions, as</td></tr>
</table>

<table>
<tr><td></td><td>well as their capacity to work collaboratively in business-oriented projects. The assessments are designed to align with the intended learning outcomes.

<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Proctored Written Test</td><td>Summative assessment to evaluate individual understanding of IoT concepts and applications.</td><td>LO1, LO4, LO5.</td><td>50%</td><td>Terminal Exam.</td></tr>
<tr><td>Group Project</td><td>Team-based IoT solution development and presentation.</td><td>LO2, LO3.</td><td>50%</td><td>End of term project.</td></tr>
<tr><td>Formative assessment</td><td>Quizzes, assignments, and case study analysis.</td><td>LO1-LO5</td><td>-</td><td>Biweekly</td></tr>
</table></td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
<tr><td>Reading list</td><td><u>Recommended Resources</u>

Davies J, Fortuna C, editors. The Internet of Things: From Data to Insight. 1st ed. Wiley; 2020.
Greengard S. The Internet of Things. MIT Press; 2015.
Gunjal PR, Jondhale SR, Mauri JL, Agrawal K. Internet of Things: Theory to Practice. 1st ed. CRC Press; 2024.
Gupta PK. IoT and data analytics for business. Cambridge (MA): MIT Press; 2017.
Johnson A, Smith B. The impact of IoT on business models. New York (NY): Springer; 2018.
Lee C. Internet of Things (IoT) in business: A comprehensive overview. J Bus Inf Technol. 2020;19(2):115-30.
Patel K, Singh R. IoT architecture for business applications. In: Advances in IoT Architecture. CRC Press; 2019. p. 45-67.
Shackelford SJ. The Internet of Things: What Everyone Needs to Know. Oxford University Press USA; 2020.
Thompson L, Zhou M. Security challenges in the Internet of Things for business. Int J IoT Secur Res. 2021;4(1):22-39.
Uckelmann D, Harrison M, Michahelles F, eds. Architecting the Internet of Things. Springer; 2011.
</td></tr>
</table>

	• Weber RH, Weber R. Internet of Things – Legal Perspectives. Springer; 2010. Supplementary Resources • Ashton K. That 'internet of things' thing. RFiD J. 2009;22(7):97-114. • Bi Z, Da Xu L, Wang C. Internet of Things for Enterprise Systems of Modern Manufacturing. IEEE Trans Ind Inform. 2014;10(2):1537-1546. • International Telecommunication Union (ITU). ITU-T Y.2060: Overview of the Internet of things. 2012. Available from: https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=y.2060 • Institute of Electrical and Electronics Engineers (IEEE). IEEE Standard for an Architectural Framework for the Internet of Things (IoT). IEEE Std 2413-2019. • Internet Engineering Task Force (IETF). RFC 7252: The Constrained Application Protocol (CoAP). 2014. • Khanna A, Kaur S. Internet of Things (IoT), Applications and Challenges: A Comprehensive Review. Wirel Pers Commun. 2020;114, 1687–1762. • Miorandi D, Sicari S, De Pellegrini F, Chlamtac I. Internet of things: Vision, applications and research challenges. Ad Hoc Netw. 2012;10(7):1497-1516. • O'Reilly T, Tushman ML. IoT business models: Exploring the emerging landscape. Harv Bus Rev. 2016;94(3):128-37. • Rahman A, Sadiq S. Leveraging IoT for business process automation. J Bus Technol. 2022;8(4):210-25. • Walters D, Patel N. Programming the Internet of Things for business applications. San Francisco (CA): Jossey-Bass; 2015. • Wan J, Tang S, Shu Z, Li D, Wang S, Imran M, Vasilakos AV. Software-Defined Industrial Internet of Things in the Context of Industry 4.0. IEEE Sens J. 2016;16(20):7373-7380. • Zhang Y, Li H. IoT in industries: A survey of applications, practices, and challenges. Bus Horiz. 2018;61(4):539-51.

Blockchain Technologies

<table>
<tr><td>Module designation</td><td colspan="2">Blockchain Technologies</td></tr>
<tr><td>Offered as micro-credential</td><td colspan="2">No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td></td><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td></td><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
<tr><td>Partner responsible for the module</td><td colspan="2"><u>NCI</u></td></tr>
<tr><td>Person responsible for the module</td><td colspan="2">Horacio González-Vélez</td></tr>
<tr><td>Language</td><td colspan="2">English</td></tr>
<tr><td>Relation to curriculum</td><td colspan="2">Elective</td></tr>
</table>

<table>
<tr><td>Teaching methods</td><td>The teaching methodology for this module will include the following components:
Online Delivery: Use of accessible asynchronous content (e.g., video lectures and case studies) tailored to non-computing backgrounds. It will also incorporate discussion fora for peer-to-peer learning.
Problem-Based Learning: Simplify project scope: Develop proposals rather than full prototypes (e.g., "How blockchain improves traceability in supply chains").
Business Simulations: Use role-play or decision-making games to demonstrate blockchain’s impact on business operations.
Hands-on Labs: Conduct sessions on interacting with blockchain applications (e.g., using public block explorers or deploying pre-configured smart contracts via user-friendly interfaces).
Collaborative Exercises: Team-based Assignments: Groups analyse real-world blockchain implementation cases and deliver strategic recommendations.
Flipped Classroom Approach: Pre-class content includes business-friendly readings (e.g., blockchain in supply chains) and video explainers. There will be in-class activities focus on discussions, group work, and practical exercises.</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>77</td></tr>
<tr><td>Total (hours)</td><td>125</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Basic Understanding of Business Operations.
2. Familiarity with Digital Transformation fundamentals, typically acquired via the Digital Transformation module.
3. Analytical Thinking Skills.
4. Familiarity with Databases and Networking concepts.</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>The module aims to enable learners to evaluate and appraise the impact of blockchain in modern business environments. The emphasis on business problem-solving frameworks ensures non-technical learners can contextualise blockchain in familiar organisational settings and explore the underlying programming concepts, protocols, and key aspects of blockchain technologies. Furthermore, this module explores ethical and legal issues associated with adoption of blockchain</td></tr>
</table>

	technologies and considers how blockchain technologies can be leveraged for potential competitive business advantage. Transferable skills such as teamwork, communication, and collaboration are included to cater to cross-disciplinary roles. Upon successful completion of this module, learners will be able to: **LO1:** Critically assess blockchain technologies and their revolutionary impact on financial systems, integrating analysis of core components and pioneering use cases. **LO2:** Analyse and differentiate between blockchain protocols, addressing ethical, legal, and practical adoption challenges, to foresee the technology's evolving landscape. **LO3:** Develop communication skills by presenting blockchain-based business solutions to stakeholders with varying levels of technical knowledge. **LO4:** Collaborate effectively within multidisciplinary teams to design and implement a blockchain application, employing critical analysis to evaluate its infrastructure and applicability within various contexts. **LO5:** Strategize blockchain integration within enterprises, synthesising technological and regulatory insights to navigate and leverage emerging opportunities.

Content

Blockchain Technologies is a 5 ECTS module delivered over 4 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:

	Lecture Topic	Lecture Detail
1	Introduction	Introduction to Blockchain and Cryptocurrency. Historical Context of Blockchain and Cryptocurrencies. Overview of Different Blockchain Types. Introduction to the Blockchain Stack and its Core Components
2	Blockchain Stack and Core Components	In-depth Discussion on Web3 and Technological Fundamentals. Detailed Analysis of Block Composition and Consensus Mechanisms (POET/ POB/ POS/ POW). Basics of Distributed Systems and Distributed Ledger Technology (DLT). Cryptographic Foundations: Hashing and the Merkle Tree
3	Blockchain Management	Principles of Decentralization and Brewer's CAP Theorem. Examination of Public, Private, and Enterprise Blockchains. Business Case Development for Blockchain Applications
4	Cryptocurrencies and the Blockchain	Handling Cryptocurrencies: Storage, Use, and Wallets. Exploration of Altcoins and Mining Processes. Overview of Recent Trends and Developments in the Cryptocurrency Space
5	Evolution of Blockchain	Detailed Study on the Evolution and Revolution of Blockchain: From Bitcoin to Hyperledger. Discussion on Enterprise Blockchain, Digital Identities, and Current Use Cases
6	Security, Identity & Cryptography in Blockchain	The CIA Triad in Blockchain: Confidentiality, Integrity, Authentication. Exploration of Symmetric and Asymmetric Encryption, Non-Repudiation, and Public/Private Keys. Hash Functions, Digital Signatures, Anonymity, and the Concept of Self-Sovereign Identity (SSI)
7	Blockchain Applications I- Bitcoin	Comprehensive Overview of the Bitcoin System and Stack. Examination of Bitcoin Transactions, the P2P Network, and the Mining Process. Consensus Mechanisms: Proof of Work (POW)
8	Blockchain Applications II- Ethereum	Comprehensive Overview of the Ethereum System. Smart Contracts, Decentralized Applications (DApps), and the Ethereum Virtual Machine (EVM). Introduction to DAOs, Decentralized Finance (DeFi), and NFTs
9	DApp Development I	Introduction to DApp Development Environments and the Web3 Stack. Basics of NodeJS and Express in the Context of Blockchain

<table>
<tr><td></td><td>
<table>
<tr><td>10</td><td>DApp Development II</td><td>Advanced Tools for DApp Development: Infura, RemixIDE, ERC Smart Contracts. Practical Use of Ganache, Truffle, and Blockchain APIs</td></tr>
<tr><td>11</td><td>Legal & Ethical Aspects of Blockchain</td><td>Discussion on the Regulatory Landscape for Cryptocurrencies and Tokens. Anti-Money Laundering (AML), Counter-Terrorist Financing (CTF), Know Your Customer (KYC), and Know Your Transaction (KYT) Requirements. Ethical Considerations and Ongoing Legal Dynamics</td></tr>
<tr><td>12</td><td>Emerging Topics in Blockchain</td><td>Exploration of Current Research Directions and Emerging Topics: CBDCs, Privacy, the Metaverse, and Quantum Computing's Impact on Blockchain</td></tr>
</table>
</td></tr>
<tr><td>Exams and assessment formats</td><td>
Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway. Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment tools (e.g., examinations, assignments, projects, exercises) will allow direct measurement of the students' knowledge, skills, and competences.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Project</td><td>Team project focusing on developing a blockchain solution to support a defined business process.</td><td>LO3, LO4</td><td>50%</td><td>Week 12</td></tr>
<tr><td>Proctored Written Test</td><td>The test will assess learners’ knowledge and understanding of blockchain technologies.</td><td>LO1, LO2, LO4</td><td>50%</td><td>Terminal Exam.</td></tr>
</table>
</td></tr>
</table>

Study and examination requirements	Students must have an overall final grade of 40% or higher to pass this module.
Reading list	Recommended Resources • Antonopoulos AM, Harding D. Mastering Bitcoin: Programming the Open Blockchain. 3rd ed. O'Reilly Media; 2023. • Banoth R, Regar R. Classical and Modern Cryptography for Beginners. Springer; 2023. • Bashir I. Mastering Blockchain: Inner workings of blockchain, from cryptography and decentralized identities, to DeFi, NFTs and Web3. 4th ed. Packt Publishing; 2023. • De Filippi P. Blockchain and the Law: The Rule of Code. Reprint edition. Harvard University Press; 2019. • Hellwig D, Karlic G, Huchzermeier A. Build Your Own Blockchain: A Practical Guide to Distributed Ledger Technology. 1st ed. 2020. Springer; 2020. • Mougayar W. The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology. Wiley; 2016. • Pagano AM, Liotine M. Technology in Supply Chain Management and Logistics: Current Practice and Future Applications. 2nd ed. Elsevier; 2025. Supplementary Resources • Di Maggio M. Blockchain, Crypto and DeFi: Bridging Finance and Technology. 1st ed. Wiley; 2024. • Hirtan L-A, Dobre C, González-Vélez H. Blockchain-based Reputation for Intelligent Transportation Systems. Sensors. 2020;20(3):791. • Leal F, Chis AE, González-Vélez H. Multi-service model for blockchain networks. Inf Process Manag. 2021;58(3):102525. • Leal F, Chis AE, González-Vélez H. Performance Evaluation of Private Ethereum Networks. SN Comp Science. 2020;1(5):285. • Leal F, Veloso B, Malheiro B, Burguillo JC, Chis AE, González-Vélez H. Stream-based explainable recommendations via blockchain profiling. Integr Comput-Aided Eng. 2022;29(1):105-121. • Nakamoto, S. "Bitcoin: A Peer-to-Peer Electronic Cash System." 2008. Available from: https://bitcoin.org/bitcoin.pdf • Wood, G. "Ethereum: A Secure Decentralised Generalised Transaction Ledger." Ethereum Project Yellow Paper; 2014. PARIS version 705168a – 2024-03-04 Available from: https://ethereum.github.io/yellowpaper/paper.pdf

Quantum Computing

<table>
<tr><td>Module designation</td><td>Quantum Computing</td></tr>
<tr><td>Offered as micro-credential</td><td>No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>
<table>
<tr><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
</table>
</td></tr>
<tr><td>Partner responsible for the module</td><td><u>NCI</u></td></tr>
<tr><td>Person responsible for the module</td><td>Jorge Mario Cortés-Mendoza</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Elective</td></tr>
<tr><td>Teaching methods</td><td>This module uses a variety of teaching methods tailored for business leaders to facilitate both understanding and practical application:
Asynchronous Lectures: Online sessions led by experts, focusing on core concepts and their relevance to business problems.
Case Study Analysis: Participants will analyse real-world case studies of quantum computing applications in various industries.
Group discussions: Held to foster critical thinking and collaborative problem-solving.
Workshops: Interactive laboratories and workshops focusing on quantum-inspired strategies and solution design.
Hands-on exercises: using quantum simulation tools to explore algorithm behaviour.
Guest Lectures: Industry experts will be invited to share insights on quantum adoption and the current landscape of quantum technology.
Group Project: Students will work in teams to design a quantum adoption strategy for a hypothetical business problem, promoting collaboration and communication skills.</td></tr>
</table>

<table>
<tr><td></td><td>

- **Discussion Forum***:* Online forum will enable participants to engage with peers and instructors, share insights, and discuss quantum computing trends.

</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td>
<table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>92</td></tr>
<tr><td>Total (hours)</td><td>140</td></tr>
</table>
</td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>

1. Business Strategy and Technology Awareness: Familiarity with basic business strategy concepts and the role of emerging technologies in business.
2. Mathematical Foundations: Basic understanding of linear algebra and probability theory.
3. Digital Transformation Experience: Previous exposure to digital transformation initiatives or projects involving emerging technologies (e.g., Cybersecurity, Cloud Computing).

</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>

Quantum Computing is a rapidly developing field that shows great promise for fundamentally transforming and extending the scope of computational capabilities through using key results from the theory of quantum mechanics. The physical construction of quantum computers and accessibility to quantum computing via cloud services is now a reality. This module aims to provide learners with an introduction to the theory and foundations of quantum computing and its applications for business strategy and problem-solving. The module also aims to provide learners with the practical skills to develop and implement quantum computing algorithms to solve complex business problems. This module includes a research component, where students will explore the current landscape and future potential of quantum computing evaluating its impact on various industries. This module aims to prepare students with the knowledge and skills to understand and leverage the emerging field of quantum computing in a business context.

Upon successful completion of this module, learners will be able to:

LO1: Analyse quantum computing principles and their application in solving complex business optimization problems.

LO2: Critically assess various quantum algorithms for business use cases, such as cryptography and machine learning, and recommend suitable methodologies.

</td></tr>
</table>

<table>
<tr><td></td><td>LO3: Design and implement quantum-based solutions (e.g. circuit model of quantum gates) to real-world business problems using quantum programming frameworks.
LO4: Research, evaluate, and communicate technical quantum computing concepts effectively to non-technical stakeholders, emphasising business impact.</td></tr>
<tr><td>Content</td><td>Quantum Computing is a 5 ECTS module delivered over 4 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:
<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction</td><td>Results from the theory of quantum mechanics. Spin and polarization. Measurements/Observables. Randomness and probability. Bits and Qubits. Quantum parallelism and interference.</td></tr>
<tr><td>2</td><td>Linear Vector Spaces, Hilbert Spaces, and Matrix Representations</td><td>Review of linear spaces. Hilbert spaces. Dirac <bra|ket> notation. Operations and operators. The Bloch Sphere. Pauli Matrices. Orthogonal and unitary matrices. Operations and operators. Eigenvectors and eigenvalues.</td></tr>
<tr><td>3</td><td>Quantum Circuits</td><td>Logic Gates. Reversibility. Multi-qubit Gates. Diagrammatic representation. Deutsch’s Algorithm.</td></tr>
<tr><td>4</td><td>Programming for Quantum Computing</td><td>Programming environments. Language support. Simulation. Quantum Computing cloud services. Coprocessor.</td></tr>
<tr><td>5</td><td>Entanglement</td><td>Entangled states. Bell’s Inequalities. Using the CNOT gate. No Cloning Theorem. Quantum Teleportation.</td></tr>
<tr><td>6</td><td>Quantum Information Theory</td><td>Elements from the Classical Information Theory. Information and Entropy. Quantum Information Processing and Error-Correcting Codes. Quantum Communications Channels.</td></tr>
<tr><td>7</td><td>Application Domains.</td><td>Quantum Cryptography. Quantum Key Distribution. Ekert Protocol. BB84 Protocol. Dense coding.</td></tr>
<tr><td>8</td><td>Advanced Quantum Topics</td><td>Fourier Series. Discrete Fourier Transform. Quantum Fourier Transform. Deutsch-Josza and Simon’s Algorithms.</td></tr>
<tr><td>9</td><td>Quantum Algorithms for Business</td><td>Grover’s algorithm for search optimization. Shor’s algorithm for cryptography and its implications for cybersecurity.</td></tr>
<tr><td>10</td><td>Business Case Studies</td><td>Quantum-inspired optimization techniques in logistics, finance, and supply chain. Use cases and industry applications</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>10</td><td>Industry Insights and Adoption</td><td>Analysis of successful quantum computing projects. How to create a roadmap for quantum adoption in an organisation. Identifying high-impact business areas for quantum solutions.</td></tr>
<tr><td>12</td><td>Emerging Topics</td><td>Quantum Hardware. Quantum Supremacy. Data Security. Quantum ML. Impact of business digital transformation. Ethical implications of quantum computing. Societal impact and regulatory concerns.</td></tr>
</table>
</td></tr>
<tr><td>Exams and assessment formats</td><td>
The assessment methods are carefully designed to evaluate the student attainment of quantum computing concepts, apply them in a business context, and collaborate effectively. Given the strategic and decision-making focus of this module, assessments emphasise critical thinking, strategic planning, and the ability to communicate complex quantum concepts to diverse audiences. Participants will be assessed on their understanding of quantum principles, their capacity to analyse quantum algorithms in business scenarios, and their skills to design high-level quantum adoption strategies.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Continuous Assessment</td><td>Design and implement a QC circuit to model and solve problems.</td><td>LO2, LO3, LO4</td><td>50%</td><td>Week 8</td></tr>
<tr><td>Proctored Written Test</td><td>The test will assess learners' knowledge and understanding of quantum computing and its strategic positioning for business and enterprise.</td><td>LO1, LO2</td><td>50%</td><td>Terminal Exam.</td></tr>
</table>
</td></tr>
</table>

Study and examination requirements	Students must have an overall final grade of 40% or higher to pass this module.
Reading list	Recommended Resources • Bernhardt C. Quantum computing for everyone. MIT Press; 2019. • Hidary JD. Quantum computing: An applied approach. 2nd ed. Springer; 2021. • Mermin ND. Quantum computer science. Cambridge University Press; 2007. • Nielsen MA, Chuang IL. Quantum computation and quantum information. Cambridge University Press; 2010. • Yanofsky NS, Mannucci MA. Quantum Computing for Computer Scientists. 1st ed. Cambridge: Cambridge University Press; 2008. • Zygelman B. A first introduction to quantum computing and information. Springer; 2018. Supplementary Resources • Brassard G, Chuang I, Lloyd S, Monroe C. Quantum computing. Proc Natl Acad Sci U S A. 1998 Sep 15;95(19):11032-3. • Horowitz M, Grumbling E, editors. Quantum computing: Progress and prospects. Illustrated edition. National Academies Press; 2019. • Ladd T, Jelezko F, Laflamme R, et al. Quantum computers. Nature. 2010; 464:45–53. • Preskill J. Quantum computing: pro and con. Proc R Soc Lond A Math Phys Eng Sci. 1998 Jan 8;454(1969):469-86. • Rieffel E, Polak W. An introduction to quantum computing for non-physicists. ACM Comput Surv. 2000;32(3):300–335. • Steane A. Quantum computing. Reports on Progress in Physics. 1998;61(2):117.

Data Governance and Ethics

<table>
<tr><td>Module designation</td><td colspan="2">Data Governance & Ethics</td></tr>
<tr><td>Offered as micro-credential</td><td colspan="2">No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td></td><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td></td><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
<tr><td>Partner responsible for the module</td><td colspan="2">NCI</td></tr>
<tr><td>Person responsible for the module</td><td colspan="2">John Bohan</td></tr>
<tr><td>Language</td><td colspan="2">English</td></tr>
<tr><td>Relation to curriculum</td><td colspan="2">Elective</td></tr>
<tr><td>Teaching methods</td><td colspan="2">The methodology with which the module will be delivered is a teaching methodology that integrates hybrid learning (alternating synchronous and asynchronous learning activities), and the pedagogy provided be the lecturer, who has the dual characteristic of being an expert in the contents of the module and of accompanying the students' learning process. In line with the research and experimentation of innovative teaching methods, it is envisaged that these teaching strategies will be integrated and put into practice by exploiting emerging technologies (including the ethical and appropriate use of AI tools) to enrich the teaching and learning experience within the digital platform.
• Asynchronous Sessions: Pre-recorded lectures, articles, and multimedia resources will be provided for independent study. These materials will include examples of governance strategies, legal constraints, and ethical case studies, preparing students for in-class problem-solving exercises.
• Synchronous Sessions: Weekly interactive online webinars and tutorials will cover theoretical frameworks, regulatory guidelines, and ethical principles in data governance. Each session will conclude with case discussions to foster critical thinking and application of concepts.</td></tr>
</table>

<table>
<tr><td></td><td>

- **Problem-Based Learning Workshops**: Students will work on real-world scenarios, such as designing a data governance strategy for a multinational organization or conducting an ethical audit. Students will present their findings and receive peer and instructor feedback. This approach fosters the development of governance solutions and improves communication skills by simulating real-world professional tasks.
- **Collaborative Group Projects**: In teams, students will collaborate on a project to create a governance framework or policy for a specific business problem. This includes identifying risks, proposing solutions, and preparing a presentation for stakeholders.
- **Flipped Classroom**: Students will review core concepts independently before live sessions, where class time is used for deeper analysis and problem-solving activities.
- **Industry Guest Lectures and Panel Discussions**: Industry professionals will deliver guest lectures, sharing insights into real-world data governance challenges and solutions and allowing students to engage with practitioners and deepen their understanding of ethical and governance issues.
- **Peer Reviews**: Peer-to-peer learning via online wikis and AI enabled tools will enable students to debate governance strategies and ethical dilemmas. Peer review exercises will help students improve their critical thinking and communication skills.

</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td>
<table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>77</td></tr>
<tr><td>Total (hours)</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>

1. Basic knowledge of data management concepts and business operations.
2. Introductory understanding of information systems and regulatory frameworks (e.g., GDPR, Digital Services Act).
3. Familiarity with organisational processes and basic analytical skills.

</td></tr>
</table>

Module objectives/intended learning outcomes	This module focuses on the critical aspects of data governance and regulatory compliance in the context of data acquisition, storage, and transformation. Students will learn to assess and compare various data governance frameworks and understand the legal and ethical implications of managing data. Students will critically analyse managerial and ethical considerations in business data handling, artificial intelligence fairness, and develop strategies to manage data ethically and responsibly. This module emphasises the development of key transferable skills essential for professional success in data governance and ethics: • Problem-Solving Skills: Students will apply governance methodologies to complex, real-world business scenarios. • Communication Skills: Emphasized through report writing, presentations, and stakeholder engagement exercises. • Collaboration Skills: Developed through group-based case study analysis and collaborative projects. • Ethical Reasoning: Strengthened by engaging with ethical dilemmas and debates on real-world governance issues. • Service Orientation: Encouraged through tasks that require students to design governance frameworks that balance stakeholder needs with regulatory compliance. This module will also address the growing importance of artificial intelligence in data analysis ensuring students comprehend the technical and legal facets of data management and appreciate the ethical and societal impacts, preparing them for responsible leadership in the digital business environment. Upon successful completion of this module, learners will be able to: **LO1:** Assess and critically compare data governance and regulatory processes for data acquisition, storage, and transformation in diverse business contexts. **LO2:** Design and propose solutions to business challenges using data governance strategies, emphasizing regulatory compliance and ethical considerations. **LO3:** Assess and implement effective data governance practices by applying appropriate methodologies such as gap analysis and risk assessment. **LO4:** Communicate complex data governance and ethics issues effectively to diverse stakeholders, promoting ethical practices within organizations. **LO5:** Enhance transparency and explainability of AI-generated data insights.

<table>
<tr><td>Content</td><td>Data Governance and Ethics is a 5 ECTS module delivered over 4 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:

<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to Data Governance (DG)</td><td>Overview of data governance. Importance and objectives of data governance in contemporary organisations</td></tr>
<tr><td>2</td><td>Big Data Management Principles</td><td>Data lifecycle management. Principles of data quality, data provenance and data generation; Understanding master data and its importance. Methods for assessing and improving data quality.</td></tr>
<tr><td>3</td><td>Data Integrity and Security</td><td>Techniques and practices for ensuring data integrity. Data security challenges and strategies. Implementing master data management and data quality processes</td></tr>
<tr><td>4</td><td>Data Governance Frameworks</td><td>Examining policies, principles, rules, and procedures. Different operating models. Implementation challenges and best practices</td></tr>
<tr><td>5</td><td>Data Architecture and metadata Management</td><td>Designing data architecture tailored to enterprise needs. Using metadata to enhance data governance and usage. Integrating metadata management tools into enterprise IT infrastructure.</td></tr>
<tr><td>6</td><td>Data Risk Management</td><td>Understanding data-related risks. Roles, responsibilities, and maturity levels in risk management. Assessing risks related to data Managing risks related to data confidentiality and security. Ensuring regulatory compliance with data.</td></tr>
<tr><td>7</td><td>Implementing Data Governance for business value creation</td><td>Aligning data governance with business strategy. Identifying stakeholders and responsibilities. Developing data governance policies and standards. Utilizing data for predictive analysis and decision-making
Use cases of data analytics to enhance business processes. Strategies for monetizing data and creating new business models</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>8</td><td>Ethical Concepts and Frameworks</td><td>Introduction to ethics in data management. Ethical principles, standards, and practice</td></tr>
<tr><td>9</td><td>Privacy, Analytics, and Ethics</td><td>Balancing analytics ambitions with privacy laws and ethical standards. Case studies.</td></tr>
<tr><td>10</td><td>Ethics and AI</td><td>Ethical considerations in AI and ML. Mitigating biases and ensuring fairness.</td></tr>
<tr><td>11</td><td>Governance of AI and Advanced Analytics</td><td>Emerging trends and challenges in AI governance. Regulatory and ethical frameworks for AI</td></tr>
<tr><td>12</td><td>Business Data Ethics and Future Trends</td><td>Applying ethical principles in business data analytics. Future trends in data governance and ethics</td></tr>
</table>
</td></tr>
<tr><td>Exams and assessment formats</td><td>Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway. Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment tools (e.g., examinations, assignments, projects, exercises) will allow direct measurement of the students' knowledge, skills and competences.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Project</td><td>Research or application project.</td><td>LO2, LO3, LO5</td><td>50%</td><td>Week 12</td></tr>
<tr><td>Proctored Written Test</td><td>-Individual and group practical assignments
-Analysis of legal texts on norms and standards for data use and governance</td><td>LO1, LO4</td><td>50%</td><td>Terminal Exam.</td></tr>
</table>
</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
</table>

Reading list	Recommended Resources • Bob G, et al. Data Governance: How to Design, Deploy and Sustain an Effective Data Governance Program. 2nd ed. Academic Press; 2018. • Duke T. Building Responsible AI Algorithms: A Framework for Transparency, Fairness, Safety, Privacy, and Robustness. 1st ed. Apress; 2023. • Fleming G, Bruce PC. Responsible Data Science: Transparency and Fairness in Algorithms. 1st ed. Wiley; 2021. • Jules P, et al. Ethical and Social Issues in the Information Age. 6th ed. Springer; 2017. • Ladley J. Data governance: how to design, deploy and sustain an effective data governance program. The Morgan Kaufmann Series on Business Intelligence. 2020. • Martin K, et al. Ethics and Data Science. O'Reilly Media; 2018. • Weill P, Ross JW. Data Governance: How to Design, Deploy, and Sustain an Effective Data Governance Program. MIT Press; 2017. Supplementary Resources • Alhassan I, Sammon D, Daly M. Data governance activities: an analysis of the literature. J Decis Syst. 2016;25(sup1):64-75. • Abraham R, Schneider J, vom Brocke J. Data governance: A conceptual framework, structured review, and research agenda. Int J Inf Manag. 2019; 49:424-438. • Bruce PC, Khatri V. Designing data governance. Commun ACM. 2010;53(1):148-152. • Centre for Data Ethics and Innovation, UK Government. Review into bias in algorithmic decision-making. November 2020. https://assets.publishing.service.gov.uk/. • Executive Office of the President, US Government. Big Data: A Report on Algorithmic Systems, Opportunity, and Civil Rights. May 2016. https://obamawhitehouse.archives.gov/ • O'Keefe K, O'Brien D. Ethical data and information management: concepts, tools and methods. Kogan Page; 2018. • Polonetsky J, Tene O, Jerome J. Privacy in the Age of Big Data: A Time for Big Decisions. Stanford Law Review. 2016;64(63). • Songul T. Fair and Unbiased Algorithmic Decision Making: Current State and Future Challenges. European Commission. JRC nr: JRC113750. Publication date: 12 July 2019. https://joint-research-centre.ec.europa.eu/ • Zarsky T. The Trouble with Algorithmic Decisions: An Analytic Road Map to Examine Efficiency and Fairness in Automated and Opaque Decision Making. Science, Technology, & Human Values. 2016;41(1):118-132.

Innovation

<table>
<tr><td>Module designation</td><td colspan="2">Innovation</td></tr>
<tr><td>Offered as micro-credential</td><td colspan="2">No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td></td><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td></td><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
<tr><td>Partner responsible for the module</td><td colspan="2"><u>UNIBO</u></td></tr>
<tr><td>Person responsible for the module</td><td colspan="2">Anita Macauda (scientific responsibility)
Maria Cristina Garbui (organisational responsibility)</td></tr>
<tr><td>Language</td><td colspan="2">English</td></tr>
<tr><td>Relation to curriculum</td><td colspan="2">Elective</td></tr>
<tr><td>Teaching methods</td><td colspan="2">Teaching is fully online. The module employs hybrid learning, alternating synchronous and asynchronous activities, facilitated by a tutor. Key methods include:
Collaborative Learning: Techniques like brainstorming, collaborative problem-solving, and gamified tasks.
Practical Tools: Use of design thinking, case study discussions, and project-based learning for hands-on experiences.
Outcome Alignment: Emphasis on integrating learning outcomes with activities and assessments.</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td>Classroom & Demonstrations (hours)</td><td>18</td></tr>
<tr><td></td><td>Other hours (Practical work /Tutorial)</td><td>12</td></tr>
<tr><td></td><td>Independent learning (hours)</td><td>95</td></tr>
<tr><td></td><td>Total (hours)</td><td>125</td></tr>
</table>

Credit points	5 ECTS
Recommended prerequisites for joining the module	1. Fundamental understanding of organizational strategy and operations. 2. Basic knowledge of digital tools and platforms. 3. Exposure to entrepreneurial thinking or project management is beneficial.
Module objectives/intended learning outcomes	The module aims to enable learners to understand, discuss, and summarise Innovation and the main Innovation Implementation strategies. This curricular unit intends to develop methodological and research skills on the lead of innovation. This module on innovation is designed to develop a deep understanding of the creative development process and the strategic application of innovative methods across different contexts. Students will gain a critical awareness of how creative and innovative strategies can be implemented effectively to drive business growth and transformation. Students will evaluate and explore a range of case studies and innovation techniques providing them with insights into successful creative practices and methodologies. The module will focus on the tangible impacts and return on investment that innovation can bring. Students will learn to quantify and communicate the value of creative efforts, linking innovation to business outcomes. Students will understand the theory behind innovation and can apply these principles practically to drive real-world business success. Upon successful completion of this module, learners will be able to: **LO1:** Demonstrate a critical awareness of the creative development process and the application of creative and innovative strategies in a variety of contexts. **LO2:** Evaluate and explore various case studies and innovation techniques to help understand creative and innovative practices. **LO3:** Discern, critique, and apply the various techniques to foster creative talent environments at an individual, team, and organisational level. **LO4:** Demonstrate impacts and return on investment at an individual and organisational level. **LO5:** Create and explore strategies to deliver the results of creative work in business.

Content

Innovation is a 5 ECTS module delivered over 4 hours 10 minutes per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:

	Lecture Topic	Lecture Detail
1	Fundamentals of Innovation I	Creativity and Innovation: Introduction to creativity and its role in innovation. Discussion on the creative process and techniques to foster creativity. Examples of how creativity has driven significant technological advancements.
2	Fundamentals of Innovation II	Emotional Intelligence and Entrepreneurship: Definition and importance of emotional intelligence in entrepreneurship. The role of emotional intelligence in decision-making leadership. Practical exercises to develop emotional intelligence.
3	Innovation and Business Models I	Innovation Management in Business: Introduction to innovation management principles and its role in businesses. Identifying innovation drivers and their relationship with entrepreneurship. Case studies of companies that have successfully implemented innovative business models.
4	Innovation and Business Models II	Designing Innovative Business Models: Developing innovative business models for emerging technologies such as blockchain and 3D printing. Assessing the financial and strategic implications of new business models. Group exercises for creating and evaluating innovative business models.
5	Strategic Innovation and Entrepreneurial Leadership I	Data-Driven Innovation and Product Design: Using data analysis and product design to drive innovation in entrepreneurship. Practical examples of data-driven decision-making in business. Case studies showcasing successful entrepreneurial ventures based on data and design.
6	Strategic Innovation and Entrepreneurial Leadership II	Leading Collaborative Innovation Projects: Leading collaborative innovation projects and the role of entrepreneurial leadership. Effective team dynamics and communication in innovation. Learning from both successful and failed collaborative innovation projects.
7	Entrepreneurial Communication Strategies I	Effective Communication for Technology: Developing persuasive communication strategies for technology-based ventures. Using corporate storytelling and design thinking in technology-related communication. Practical exercises on creating impactful communication plans.

	8	Entrepreneurial Communication Strategies II	Engaging Stakeholders through Corporate Stories: The power of corporate storytelling in engaging stakeholders. Examples of successful corporate story-driven communication. Group discussions on how to apply corporate stories to technology-driven ventures.
	9	Solving Complex Problems I	Problem-Solving in Technology: Applying problem-solving concepts to technological challenges, including machine learning and robotics. Case studies demonstrating effective problem-solving strategies in the tech industry. Group exercises for hands-on problem-solving in technology.
	10	Solving Complex Problems II	Leveraging Data Analysis and Simulations: Using data analysis and simulations to address complex technological problems. Practical application of data-driven decision-making in technology. Case studies on how data-driven solutions have driven innovation.
	11	Between Innovation, Ethics, and Sustainability I	Ethical Innovation and Sustainability: Exploring the intersection of innovation, ethics, and sustainability in technologies like renewable energy and sustainable mobility. Identifying ethical and environmental challenges in technological solutions. Examples of innovations that promote ethical and sustainable practices.
	12	Between Innovation, Ethics, and Sustainability II	Assessing Environmental and Social Impact: Methods for assessing the environmental and social impact of technologies. Practical exercises in evaluating the sustainability of tech-driven solutions. Case studies of technology initiatives that have positively impacted the environment and society.
Exams and assessment formats	Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway.		

<table>
<tr><td></td><td>Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment tools (e.g. examinations, assignments, projects, exercises) will allow direct measurement of the students' knowledge, skills and competences.

<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Proposal</td><td>This is an initial proposal that must address customer segment, problem definition and solution architecture) as well as other key elements of a business model.</td><td>LO1, LO2, LO3</td><td>40%</td><td>Ongoing</td></tr>
<tr><td>Project</td><td>Minimum Viable Product (MVP) to address all key elements of a business model.</td><td>LO4, LO5</td><td>60%</td><td>Terminal Project</td></tr>
</table>
</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
<tr><td>Reading list</td><td><u>Recommended Resources</u>

Christensen CM. The innovator's dilemma: when new technologies cause great firms to fail. Reprint ed. Boston, Massachusetts: Harvard Business Review Press; 2013.
Cooper RG. Winning at new products: creating value through innovation. 5th ed. New York: Basic Books; 2017.
Goleman D. Emotional intelligence. New York: Bantam Books; 1995.

</td></tr>
</table>

	• Osterwalder A, Pigneur Y. Business model generation: A handbook for visionaries, game changers, and challengers. Hoboken, NJ: John Wiley & Sons; 2010. • Ries E. The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. New York: Crown Business; 2011. • Sternberg RJ, Lubart TI. The concept of creativity: Prospects and paradigms. In: Sternberg RJ, editor. Handbook of creativity. Cambridge: Cambridge University Press; 1999. p. 3-15. • Trott P. Innovation management and new product development. 7th ed. Harlow, England: Pearson; 2021. • Weinzimmer LG, Michel EJ. The innovation paradox: Why good businesses kill breakthroughs and how they can change. New York: Free Press; 201 Supplementary Resources • Amabile TM. The social psychology of creativity: A componential conceptualization. J Pers Soc Psychol. 1983;45(2):357-76. • Brown T. Design thinking. Harvard Business Review. 2008 Jun;86(6): 84-92. • Corazza GE, Darbellay F, Lubart T, Panciroli C. Developing intelligence and creativity in education: Insights from the space-time continuum. In: Creativity and Learning. London: Palgrave Macmillan; 2021. p. 69-87. • Ferrari L, Macauda A, Soriani A, Russo V. Educational robotics and artificial intelligence education: What priorities for schools? = Robotica educativa ed educazione all'intelligenza artificiale: Quali priorità per la scuola? FORM@RE. 2020;20. • Panciroli C, Rivoltella PC. Can an algorithm be fair? Intercultural biases and critical thinking in generative artificial intelligence social uses. SCHOLÉ. 2023; 2:67-84. • Panciroli C, Rivoltella PC. The cooperation human-machine: Educating for creativity in the AI age. In: IMG23. Alghero: PUBLICA; 2023. p. 82-89. • Porter ME, Kramer MR. Creating shared value. Harvard Business Review. 2011 Jan-Feb;89(1/2):62-77

Generative AI

<table>
<tr><td>Module designation</td><td>Generative AI</td></tr>
<tr><td>Offered as micro-credential</td><td>No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>
<table>
<tr><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
</table>
</td></tr>
<tr><td>Partner responsible for the module</td><td><u>UNL</u></td></tr>
<tr><td>Person responsible for the module</td><td>Mauro Castelli</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Elective</td></tr>
<tr><td>Teaching methods</td><td>The module employs targeted and specific teaching strategies to ensure the practical and theoretical mastery of generative AI concepts while developing transferable skills such as critical thinking, problem-solving, and innovation:
Synchronous Online Lectures: Provide foundational knowledge of generative AI concepts and their real-world applications, with opportunities for live Q&A and discussion.
Case Study Analysis: Focused sessions on real-world use cases of generative AI in industries such as healthcare, marketing, and transportation to develop problem-solving and critical analysis skills.
Flipped Classroom Approach: Students engage with pre-class materials (recorded lectures, tutorials, and research papers) and apply their knowledge through in-class activities.
Project-Based Learning (PBL): Collaborative projects require students to design, implement, and evaluate generative AI models in business contexts, fostering teamwork and innovation</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>18</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>18</td></tr>
<tr><td>Independent learning (hours)</td><td>90</td></tr>
<tr><td>Total (hours)</td><td>125</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Basic understanding of technology and its applications in business.
2. Familiarity with digital tools and platforms (e.g., basic software like Excel, Word).
3. Interest in exploring innovative AI-driven solutions for business challenges.</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>This module equips students with practical knowledge and advanced techniques to harness the transformative potential of generative AI for business innovation, emphasizing ethics, creativity, and problem-solving.
Learning Outcomes (LOs):
Upon successful completion of the module, students will be able to:
LO1: Analyse and differentiate between core principles and mechanisms of generative AI technologies, including text, image, video, and code generation. (Transferable Skills: Analytical Thinking, Critical Thinking)
LO2: Evaluate recent advancements in generative AI through academic and industry research, understanding their applications and limitations. (Transferable Skills: Research and Communication Skills)
LO3: Design and implement effective prompt engineering strategies for optimizing generative AI outputs in diverse contexts. (Transferable Skills: Problem Solving, Creativity)
LO4: Integrate generative AI models into real-world applications, assessing their impact and effectiveness in business scenarios. (Transferable Skills: Innovation, Leadership)
LO5: Identify and exploit opportunities for generative AI innovation to create novel business solutions across multiple sectors. (Transferable Skills: Service Orientation, Creativity)</td></tr>
</table>

<table>
<tr><td>Content</td><td>Generative AI is a 5 ECTS module delivered over 3 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:
<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction to Generative AI</td><td>Overview of generative AI, its history, and recent advancements. Introduction to generative models like GANs, VAEs, and diffusion models with a focus on their potential to transform business operations and creative industries.</td></tr>
<tr><td>2</td><td>Natural Language Processing Fundamentals</td><td>Foundations of Natural Language Processing (NLP), including encoders and decoders, and their role in enabling generative AI applications like chatbots, document summarization, and language translation for business needs.</td></tr>
<tr><td>3</td><td>Transformer Architectures</td><td>In-depth exploration of transformer architectures like BERT, their applications, and their impact on language models and generative AI.</td></tr>
<tr><td>4</td><td>Automating Work with Code and Content Generation (Part 1)</td><td>Leveraging generative AI models for automating tasks in software development, document creation (e.g., Excel, Word), and business content generation.</td></tr>
<tr><td>5</td><td>Automating Work with Code and Content Generation (Part 2)</td><td>Hands-on experience in using generative AI models for creating websites and web applications.</td></tr>
<tr><td>6</td><td>Automating Work with Code and Content Generation (Part 3)</td><td>Application of generative AI in mobile app development, with emphasis on designing business-focused, user-friendly mobile solutions.</td></tr>
<tr><td>7</td><td>The Creative Potential of Generative Art (Part 1)</td><td>Exploring generative art, including generating images, music, and videos with models like DALL-E, MuseNet, and GPT-3.</td></tr>
<tr><td>8</td><td>The Creative Potential of Generative Art (Part 2)</td><td>Hands-on experience in prompt engineering for generative art, enabling new forms of human-AI creativity and collaboration.</td></tr>
<tr><td>9</td><td>Developing Responsibly with Generative AI (Part 1)</td><td>Examining sources of bias and ethical implications of synthetic content generated by AI models.</td></tr>
<tr><td>10</td><td>Developing Responsibly</td><td>Exploring transparency, accountability, and regulatory considerations for the</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td><table>
<tr><td></td><td>with Generative AI (Part 2)</td><td>development and deployment of generative AI systems, ensuring alignment with business ethics and compliance standards.</td></tr>
<tr><td>11</td><td>Generative AI in Action</td><td>Real-world case studies and applications of generative AI across industries like healthcare, finance, transportation, and others.</td></tr>
<tr><td>12</td><td>New Trends and Advances in Generative AI</td><td>Cutting-edge generative research areas and innovations
Emerging techniques like diffusion models, adversarial learning, multimodal models
Novel applications and domains for generative models</td></tr>
</table></td></tr>
<tr><td>Exams and assessment formats</td><td>Assessments are designed to ensure alignment between learning outcomes, teaching methods, and transferable skills.
Assessment Types:
Project (60%): Practical project requiring the design, implementation, and evaluation of a generative AI solution for a business application.
LOs Addressed: LO2, LO3, LO4, LO5
Skills Measured: Innovation, teamwork, creativity, and technical expertise.
Proctored Written Test (40%): Summative assessment evaluating knowledge of generative AI principles and their application.
LOs Addressed: LO1, LO2, LO3
Skills Measured: Critical thinking, analytical reasoning, and ethical awareness.</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
</table>

Reading list	Recommended Resources • Alto V. Modern Generative AI with ChatGPT and OpenAI Models: Leverage the capabilities of OpenAI's LLM for productivity and innovation with GPT3 and GPT4. Packt Publishing; 2023. • Caelen O, Blete M-. Developing Apps With GPT-4 and ChatGPT: Build Intelligent Chatbots, Content Generators, and More. Oreilly & Associates Inc; 2023. • Lee P, Goldberg C, Kohane I. The AI Revolution in Medicine: GPT-4 and beyond. Pearson; 2023. • Molak A. Causal Inference and Discovery in Python: Unlock the secrets of modern causal machine learning with DoWhy, EconML, PyTorch and more. Packt Publishing; 2023. • Ozdemir S. Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs. Addison-Wesley; 2023. • Wolfram S. A New Kind of Science. Illustrated ed. Wolfram Media, Inc.; 2019. • Wolfram S. What Is ChatGPT Doing ... and Why Does It Work? Wolfram Media Inc; 2023. Supplementary Resources • Becker BA, et al. Programming Is Hard - Or at Least It Used to Be: Educational Opportunities and Challenges of AI Code Generation. In: SIGCSE 2023. USA: ACM; 2023. p. 500–506. • Nam D, et al. Using an LLM to help with code understanding. In: 2024 ICSE; 2024 Mar 6. IEEE; 2024. p. 881-881. • Ross SI, et al. The Programmer's Assistant: Conversational Interaction with a Large Language Model for Software Development. In: IUI '23. USA: ACM; 2023. p. 491–514. • Sarsa S, Denny P, Hellas A, Leinonen J. Automatic Generation of Programming Exercises and Code Explanations Using Large Language Models. In: ICER '22, Vol. 1. USA: ACM; 2022. p. 27–43. • Yao Y, Duan J, Xu K, Cai Y, Sun Z, Zhang Y. A survey on Large Language Model (LLM) security and privacy: The Good, The Bad, and The Ugly. High-Confidence Computing. 2024;100211.

Risk & Change Management

<table>
<tr><td>Module designation</td><td colspan="2">Risk & Change Management</td></tr>
<tr><td>Offered as micro-credential</td><td colspan="2">No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td>Full Time</td><td>Semester 1, Semester 2 (Year 1)</td></tr>
<tr><td></td><td>Part Time Accelerated</td><td>Semester 1, Semester 2, Semester 3 (Year 1)</td></tr>
<tr><td></td><td>Part Time</td><td>Semester 1, Semester 2 (Year 1)
Semester 1, Semester 2 (Year 2)</td></tr>
<tr><td>Partner responsible for the module</td><td colspan="2"><u>UNL</u></td></tr>
<tr><td>Person responsible for the module</td><td colspan="2">Guilherme Victorino</td></tr>
<tr><td>Language</td><td colspan="2">English</td></tr>
<tr><td>Relation to curriculum</td><td colspan="2">Elective</td></tr>
<tr><td>Teaching methods</td><td colspan="2">The module adopts structured, specific teaching methodologies to enhance practical understanding and transferable skills:
Synchronous Lectures: Introduce key concepts of risk and change management, incorporating real-world examples and guest lectures by industry experts.
Seminars: Facilitate in-depth discussions on digital transformation challenges, strategies, and innovations.
Case Study Analysis: Engage students with real-world case studies to critically analyse risk and change management strategies in various industries.
Project-Based Learning: Students collaboratively design and evaluate comprehensive risk and change management plans in the context of digital transformation.</td></tr>
</table>

<table>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>24</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>24</td></tr>
<tr><td>Independent learning (hours)</td><td>77</td></tr>
<tr><td>Total (hours)</td><td>125</td></tr>
</table></td></tr>
<tr><td>Credit points</td><td>5 ECTS</td></tr>
<tr><td>Recommended prerequisites for joining the module</td><td>1. Basic understanding of business processes and organisational dynamics.
2. Familiarity with current digital tools and technologies used in business environments.
3. Interest in exploring strategies for managing change and innovation in digital contexts.</td></tr>
<tr><td>Module objectives/intended learning outcomes</td><td>This module equips students with the ability to manage risk and change effectively in digital business environments, focusing on practical applications and fostering key transferable skills.

Upon successful completion of the module, students will be able to:

LO1: Articulate the core principles of risk and change management in digital environments, highlighting digital transformation dynamics and their impact on business models and workforce. (Transferable Skills: Critical Thinking, Communication)
LO2: Apply change management strategies effectively to digital transformation projects, emphasizing stakeholder engagement, communication, and organizational culture development. (Transferable Skills: Leadership, Collaboration)
LO3: Critically compare digital business models and strategies to identify associated risks and opportunities and evaluate the impact of digital disruption and innovation. (Transferable Skills: Analytical Thinking, Problem Solving)
LO4: Design and evaluate digital transformation plans incorporating risk and change management strategies, fostering innovation and digital culture while ensuring compliance with ethical standards. (Transferable Skills: Creativity, Ethical Awareness)</td></tr>
<tr><td>Content</td><td>Risk & Change Management is a 5 ECTS module delivered over 4 hours per week for 12 weeks. An indicative schedule of topics to be addressed each week is outlined below:</td></tr>
</table>

	Lecture Topic	Lecture Detail
1	Introduction to Risk and Change Management	Fundamentals of risk and change management within digital ecosystems. Explore the dynamics of digital societies and technology trends, highlighting both challenges and opportunities in digital transformation.
2	Digital Transformation and Change Management	Deep dive into digital transformation projects and the critical role of change management for their success. Focus on effective communication, stakeholder engagement, and cultivating a supportive organizational culture.
3	Digital Business Models and Strategies	Examination of prevalent digital business models and strategies, understanding their influence on industries, and the significance of innovation in spearheading digital transformation efforts.
4	Digital Workforce and Workplace Transformation	Investigation of digital technologies' impact on the workforce and workplace dynamics, including remote work, automation, and the use of collaboration tools. Discuss the management of a digital workforce.
5	Risk Management in Digital Transformation	Study of risk management within digital transformation contexts, focusing on risk identification, assessment, mitigation, and the formulation of comprehensive risk management plans.
6	Digital Disruption and Innovation	Exploration of digital disruption effects on industries and the pivotal role of innovation in driving transformation, creating novel business models, and seizing new opportunities.
7	Agile and Adaptive Leadership in Digital Environments	Insight into agile and adaptive leadership styles essential for digital transformation and change management, emphasising flexibility, resilience, and a commitment to lifelong learning.
8	Data-Driven Decision Making in Digital Environments	Introduction to the significance of data-driven decision making in digital environments, including methodologies in data analytics, visualisation, and reporting tools.
9	Digital Ethics, Privacy, and Compliance	Discussion on the ethical, privacy, and compliance challenges in digital environments, focusing on data protection, responsible tech use, and ethical guidelines development.
10	Building a Digital Culture and Fostering Innovation	Examination of the elements comprising a digital culture and methods to nurture a digital mindset within organisations, encouraging collaboration, innovation, and continuous learning.

<table>
<tr><td></td><td><table>
<tr><td>11</td><td>Digital Talent Management and Workforce Development</td><td>Analysis of talent management strategies pivotal for digital transformation success, covering attraction, retention, development of digital talent, and the importance of upskilling and reskilling.</td></tr>
<tr><td>12</td><td>Risk and Change Management Case Studies and Future Trends</td><td>Review of real-world case studies in risk and change management across various industries. Discussion on future trends, potential challenges, and the impact of emerging technologies like AI and quantum computing</td></tr>
</table></td></tr>
<tr><td>Exams and assessment formats</td><td>Assessments are designed to measure both technical knowledge and transferable skills, aligning with the learning outcomes.
Assessment Types:
Project (60%): Collaborative project requiring students to design and evaluate a risk and change management strategy for a digital transformation initiative.
LOs Addressed: LO2, LO3, LO4
Skills: Collaboration, innovation, analytical thinking, and problem-solving.
Proctored Written Test (40%): Summative assessment evaluating knowledge of risk and change management principles and their application.
LOs Addressed: LO1, LO3
Skills: Critical thinking, communication, and analytical reasoning.</td></tr>
<tr><td>Study and examination requirements</td><td>Students must have an overall final grade of 40% or higher to pass this module.</td></tr>
</table>

Reading list	Recommended Resources • Barkley B. Project Risk Management (Project Management). 1st ed. New York: McGraw Hill; 2004. • Davenport TH, Westerman G. Driving digital strategy: A guide to reimagining your business. Harvard Business Review Press; 2018 • Godfrey PC, Lauria E, Bugalla J, Narvaez K. Strategic Risk Management: New Tools for Competitive Advantage in an Uncertain Age. Illustrated ed. San Francisco: Berrett-Koehler Publishers; 2020. • Gupta PK. Integrating risk management in the change process. Cambridge (MA): MIT Press; 2018. • Johnson AM, Smith BL. Risk management in organizational change: New insights and strategies. New York (NY): Springer; 2013. • Lee CH, Patel KD. The impact of digital transformation on risk and change management. London (UK): Routledge; 2015. • Moreira ME. The Agile Enterprise: Building and Running Agile Organizations. 1st ed. New York: Apress; 2017. • Nieto-Rodriguez A. Harvard Business Review Project Management Handbook: How to Launch, Lead, and Sponsor Successful Projects (HBR Handbooks). Boston: Harvard Business Review Press; 2021. • Project Management Institute. The Standard for Program Management. 4th ed. Newtown Square: Project Management Institute; 2017. • Thompson LJ, Zhou MY. Adaptive leadership for risk and change management. San Francisco (CA): Jossey-Bass; 2017. Supplementary Resources • Bughin J, Deakin J, O'Beirne B. Digital transformation: Improving the odds of success. McKinsey Quarterly; October 2019. • Ciborra C. Imbrication of Representations: Risk and Digital Technologies. Journal of Management Studies. 2006; 43:1339-1356. • Fonseca L, Domingues J. How to succeed in the digital age? Monitor the organizational context, identify risks and opportunities, and manage change effectively. Management & Marketing. 2017;12(3): 443-455. • Kim D, Lee J. Future trends in risk and change management. J Future Bus Technol. 2023;1(1):50-65. • Kobrin SJ. Managing political risk in global business. Berkeley (CA): University of California Press; 2014. • Project Management Institute. Managing Change in Organizations: A Practice Guide. Illustrated ed. Newtown Square: Project Management Institute; 2013. • O'Reilly TJ, Tushman ML. Risk and change management in complex organizations. Harvard Business Review Press; 2019. • Rahman A, Sadiq S. Emerging technologies and risk management in business transformations. J Bus Transform. 2020;12(3):204-19. • Walters D, Patel N. Strategies for managing risk in business innovation and change. San Francisco (CA): Jossey-Bass; 2021. • Zhang Y, Li H. Risk management in the era of digital business models. Bus Horiz. 2022;65(4):539-51.

Digital Transformation Project / Practicum

<table>
<tr><td>Module designation</td><td>Digital Transformation Project / Practicum</td></tr>
<tr><td>Offered as micro-credential</td><td>No</td></tr>
<tr><td>Semester(s) in which the module is taught</td><td><table>
<tr><td>Full Time</td><td>Semester 2 (Year 1)</td></tr>
<tr><td>Part Time Accelerated</td><td>Semester 3 (Year 1)</td></tr>
<tr><td>Part Time</td><td>Semester 2 (Year 2)</td></tr>
</table></td></tr>
<tr><td>Partner responsible for the module</td><td>All partners</td></tr>
<tr><td>Person responsible for the module</td><td>Supervisors to be assigned from different industry and academic partners.</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Relation to curriculum</td><td>Mandatory</td></tr>
<tr><td>Teaching methods</td><td>Teaching is fully online.
The Digital Transformation Project / Practicum will be delivered is an innovative teaching methodology that integrates hybrid learning (alternating synchronous and asynchronous learning activities) and the figure of the tutor (who has the dual characteristic of being an expert in the contents of the module and of accompanying the students' learning process). Student learning activities are divided into synchronous lectures, asynchronous individual study activities, and laboratory activities. Among the main strategies with which the modules will be delivered are Problem Based Learning, Gamification and Flipped Classroom. In line with the research and experimentation of innovative teaching methods, it is envisaged that these teaching strategies will be integrated and put into practice by exploiting emerging technologies (including Artificial Intelligence) to enrich the teaching and learning experience within the digital platform.</td></tr>
<tr><td>Workload (incl. contact hours, self-study hours)</td><td><table>
<tr><td>Classroom & Demonstrations (hours)</td><td>12</td></tr>
<tr><td>Other hours (Practical work /Tutorial)</td><td>12</td></tr>
<tr><td>Independent learning (hours)</td><td>226</td></tr>
<tr><td>Total (hours)</td><td>250</td></tr>
</table></td></tr>
</table>

Credit points	10 ECTS
Required and recommended prerequisites for joining the module	Learner must have passed the Digital Transformation module and accrued a minimal of 30 ECTS.
Module objectives/intended learning outcomes	This module provides a plan for the Digital Transformation Project. Using state-of-the-art models, the curriculum encompasses text, image, audio, video, and data generation. Responsible development practices and ethical considerations around synthetic media are emphasised. Upon successful completion of this module, learners will be able to: **LO1:** Synthesise knowledge from core areas of the programme to propose, develop, and evaluate a significant digital transformation project for a specific industry or business. **LO2:** Apply project management principles to plan, execute, and deliver a practicum. **LO3:** Analyse the current state, identify opportunities for digital innovation, propose a transformation strategy, and outline the steps for implementation. **LO4:** Demonstrate professional communication skills by presenting and defending their project outcomes. **LO5:** Reflect on the ethical implications and sustainability of their project within a global and societal context.

<table>
<tr>
<td>Content</td>
<td>Digital Transformation Project / Practicum is a 10 ECTS module delivered over 2 hours per week for 12 weeks with a significant component of independent study. An indicative schedule of topics to be addressed each week is outlined below:

<table>
<tr><th></th><th>Lecture Topic</th><th>Lecture Detail</th></tr>
<tr><td>1</td><td>Introduction and Project Proposal Development</td><td>Overview of module objectives, expectations, and project proposal guidelines.</td></tr>
<tr><td>2</td><td>Research Methodologies</td><td>Techniques for conducting a literature review and selecting appropriate research methodologies.</td></tr>
<tr><td>3</td><td>Project Management for Digital Projects</td><td>Applying principles from "Risk & Change Management in Digital Environments" to plan digital projects.</td></tr>
<tr><td>4</td><td>Ethical Considerations and Sustainability in Digital Projects</td><td>Insights from "Data Governance and Ethics" on incorporating ethical practices and sustainability.</td></tr>
<tr><td>5-8</td><td>Core Area Integration into Practicum Development</td><td>Integration of the core area of specialisation into project development. Namely: Data Science for Business, AI for Business, Cybersecurity for Business, and/or Cloud Computing for Business.</td></tr>
<tr><td>9</td><td>Project Development Workshop</td><td>Hands-on session to develop and refine projects with peer and instructor feedback.</td></tr>
<tr><td>10</td><td>Project Presentation and Communication Skills</td><td>Enhancing communication skills for presenting complex projects.</td></tr>
<tr><td>11</td><td>Project Evaluation and Reflection</td><td>Evaluating projects based on set criteria and reflecting on learning outcomes and future research directions.</td></tr>
<tr><td>12</td><td>Project Showcase and Viva</td><td>Final presentation of projects to an audience, including a viva voce examination.</td></tr>
</table>
</td>
</tr>
</table>

<table>
<tr>
<td>Exams and assessment formats</td>
<td>Both formative (ongoing) and summative (final) assessments will be implemented in the module to measure student progress. Formative assessments can provide feedback to help students improve their overall study pathway. Clear assessment rubrics and criteria will be created for each topic, indicating how students will be assessed against learning objectives. The different assessment tools (e.g. examinations, assignments, projects, exercises) will allow direct measurement of the students' knowledge, skills, and competences.
Assessment deliverables for this module act as a capstone project.
<table>
<tr><th>Assessment Type</th><th>Assessment Description</th><th>Outcome addressed</th><th>% of total</th><th>Assessment Date</th></tr>
<tr><td>Proposal</td><td>Learners will develop a proposal for digital transformation comprising an in-depth literature review and project plan (2500 words) emphasising a specialisation area of the overall Master’s programme.</td><td>LO1, LO2</td><td>30%</td><td>Ongoing</td></tr>
<tr><td>Artefact and Report</td><td>The research paper style report shall comprise 4,000 to 6,000 words, up to 20 pages, and describes the individual research and production of a Digital Transformation solution or strategy. The written report is complemented</td><td>LO3, LO4, LO5</td><td>70%</td><td>Terminal</td></tr>
</table>
</td>
</tr>
</table>

			by a software artefact.			
Study and examination requirements	Students must have an overall final grade of 40% or higher to pass this module.					

Reading list	Recommended Resources • Berndtsson M, Hansson J, Olsson B, Lundell B. Thesis projects: a guide for students in computer science and information systems. Springer; 2008. • Biggam J. With Your Master's Dissertation: A Step-by-Step Handbook. 5th. Ed. Open University Press; 2021 • Creswell JW. Research design: Qualitative, quantitative, and mixed methods approach. 6th ed. SAGE Publications; 2022. • Greenway A, Terrett B, Bracken M, Loosemore T. Digital Transformation at Scale: Why the Strategy Is Delivery. 2nd ed. London: London Publishing Partnership; 2021. • Kock N. Information systems action research: an applied view of emerging concepts and methods. Springer; 2007. • Kupiek M. Digital Leadership, Agile Change and the Emotional Organization: Emotion as a Success Factor for Digital Transformation Projects. 1st ed. Springer; 2021. • O'Brien G, Guo X, Mason M. Digital Transformation Game Plan: 34 Tenets for Masterfully Merging Technology and Business. O'Reilly; 2019. • Project Management Institute PMI, Doty JR. The Digital Transformation Playbook: What You Need to Know and Do. Project Management Institute; 2023. Supplementary Resources • Aitken G, Smith K, Fawns T, Jones D. Participatory alignment: a positive relationship between educators and students during online master's dissertation supervision. Teaching in Higher Educ. 2022;27(6):772–786. • Augustsson G, Jaldemark J. Online supervision: a theory of supervisors' strategic communicative influence on student dissertations. High Educ. 2014; 67:19–33. • Casado-Lumbreras C, Colomo-Palacios R. Online coaching in thesis supervision: a qualitative study. In: TEEM '14. USA: ACM; 2014. p. 489–495. • Lester JD. Writing research papers: A complete guide. 15th ed. Longman; 2014. • McNiff J. You and your action research project. 4th ed. Routledge; 2009. • Zobel J. Writing for computer science. 3rd ed. Springer; 2015.

Digital 4 Business

Evolving your digital future

Legal Disclaimer

The European Commission's support to produce this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Project 101084013 — Digital4Business — DIGITAL-2021-SKILLS-01

Copyright © 2023 by Digital4Business Consortium

All rights reserved.