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# Curriculum

for the Master's degree programme in  
Artificial Intelligence and Cybersecurity

Programme code UL 066 993

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# Curriculum for the Master's degree programme in

## *Artificial Intelligence and Cybersecurity*

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## Section 1 General

- (1) The Master's degree programme in *Artificial Intelligence and Cybersecurity* is equivalent to 120 ECTS credits. This corresponds to an anticipated study duration of four semesters. The Master's degree programme in *Artificial Intelligence and Cybersecurity* is assigned to the group of engineering science degree programmes pursuant to Section 54 (1) of the Universities Act 2002 (UG).
- (2) The academic workload for the individual is indicated in ECTS credits; the workload for one year should amount to 1,500 full hours, for which 60 ECTS credits are awarded (Section 54 (2) UG). The workload comprises independent study as well as the semester hours/contact hours, including participation in assessment procedures.
- (3) The Master's degree programme in *Artificial Intelligence and Cybersecurity* is offered in English as a joint programme of study in accordance with Section 54d UG in the form of a double degree programme in cooperation with the University of Udine. Students seeking to complete the double degree programme must obtain 30 ECTS credits at the University of Udine.

## Section 2 Competency profile

The competency profile describes the academic and professional skills that students gain by completing the degree programme.

- (1) **Initial situation:** The Master's degree in *Artificial Intelligence and Cybersecurity* at the University of Klagenfurt focuses on the (linking of the) areas of artificial intelligence and cybersecurity. The aim is to enable graduates to use artificial intelligence or cybersecurity solutions in a high-quality, ethical manner. This requires sound basic knowledge and skills in the field of informatics/mathematics and deeper knowledge and skills in artificial intelligence or cybersecurity and relevant ethical aspects.

Artificial intelligence and cybersecurity are, both individually and combined, dynamic areas of knowledge that are subject to rapid change and that follow constant growth. In practice, both areas of knowledge are typically used as "foundational and enabling technologies", which facilitate other applications. Graduates of the Master's programme must therefore be able to expand their knowledge independently and work effectively in teams. Consequently, methodological, social and personal skills are necessary for the successful realisation, introduction, and beneficial utilisation of artificial intelligence and cybersecurity solutions.

A combination of independent as well as team-based research and development together with the strategic use of classical teaching should create ideal conditions for building these skills.

- (2) **Intended learning outcomes and skills:** Building on the initial situation, there are three main fields of competence in which students completing the Master's degree programme in *Artificial Intelligence and Cybersecurity* gain knowledge and skills: 1)

Specialised skills in artificial intelligence and cybersecurity, taking into account their ethical use; 2) individual and team skills; 3) practical scientific research and development. The knowledge and skills to be gained are described below in the form of learning outcomes for each field of competence:

- *Specialised skills in artificial intelligence and cybersecurity*: Knowledge and skills in the fields are acquired through appropriate basic and specialist subjects in artificial intelligence and cybersecurity. The teaching is based on current research results and thus conveys the current state of the art to students. The aim of the courses offered is to prepare students for practical, scientific and sound work and to teach them to conduct technology impact assessments. Social, ethical and legal aspects are both embedded in individual courses and addressed in specific courses.
  - *Individual and team skills*: The knowledge and skills gained through the courses enable students to research information independently as well as in teams and to develop solutions taking into account social, ethical and legal aspects. They also enable students to critically question scientific findings, technical solutions and their impact on society.
  - *Research experience and problem-solving competence (including scientific work)*: Students have the opportunity to work on a project concerning a complex issue. This gives them a feel for and experience of industrial or research projects. In this way, graduates boost their skills for solving a wide range of problems in business or administration, or when addressing research questions in the academic sphere.
- (3) **Professional fields and fields of activity**: Graduates of the Master's degree programme in *Artificial Intelligence and Cybersecurity* possess special expertise in the fields of artificial intelligence and cybersecurity. They are able to develop and implement complex solutions based on artificial intelligence and/or cybersecurity, taking into account social, ethical and legal aspects. The Master's degree programme also prepares graduates for a doctoral programme in Informatics.

### Section 3 Admission requirements

- (1) Admission to the Master's degree programme is conditional on the successful completion of a relevant Bachelor's degree programme, university of applied sciences Bachelor's degree programme, or other equivalent programme at a recognised domestic or international post-secondary educational institution (Section 64 (3) UG). Relevant Bachelor's degree programmes are Applied Informatics, Informatics, Information Management, Business Informatics, Information and Communications Engineering and the teacher training programme in Computer Science at the University of Klagenfurt as well as the Corso di Laurea in Informatica at the University of Udine.
- (2) Furthermore, the following qualitative admission conditions are stipulated for the Master's degree programme: Students who have completed a Bachelor's degree programme in an engineering science or a Bachelor's degree programme in Mathematics or Statistics or an equivalent degree programme at another domestic or international university, university of applied sciences or other recognised post-secondary educational institution not covered by Para. 1, are admitted to the Master's

degree programme if they provide evidence of knowledge in core areas of Informatics (algorithms and data structures, discrete mathematics, basic probability theory and statistics, at least basic programming experience).

- (3) People whose first language is not English must be proficient in the English language at level B2 of the Common European Framework of Reference for Languages (CEFR).
- (4) The Rectorate may regulate admission by means of a special admission procedure in accordance with Section 63a (8) UG.

#### Section 4 Degree

- (1) Graduates of this Master's degree programme will be awarded the academic title "Master" accompanied by the words "of Science" (abbreviated to "MSc"). If this title has been awarded, it must be used after the name.
- (2) Graduates who obtain at least 30 ECTS credits in the double degree programme at the University of Udine will be issued a joint certificate with the University of Udine in accordance with Section 87 (5) UG as well as being awarded the academic degree.

#### Section 5 Structure and organisation of the degree programme

The required subjects, the restricted electives and the unrestricted electives must be completed as part of the Artificial Intelligence and Cybersecurity Master's degree programme. In addition, a Master's thesis must be prepared, the associated exclusive tutorial and critical reflection must be completed. Table 1 shows the structure of the Artificial Intelligence and Cybersecurity Master's degree programme.

**Table 1: The structure of the Artificial Intelligence and Cybersecurity Master's degree programme**

Subject/ course unit	Subject designation	Intended learning outcomes	ECTS credits
Required subjects	1 Foundations of Artificial Intelligence and Cybersecurity	Students are able to identify the essential technical, ethical and legal bases for using artificial intelligence and cybersecurity, and can: - Identify and apply technical and mathematical principles relevant to artificial intelligence and cybersecurity - Explain the social, ethical, and legal foundations relevant to artificial intelligence and cybersecurity	8
	2 Artificial Intelligence	Students are able to explain the key concepts and methods of artificial intelligence, and can: - Design artificial intelligence systems - Identify and apply appropriate methods for specific areas of interest in the field of artificial intelligence	14

		<ul style="list-style-type: none"> <li>- Analyse the limits of artificial intelligence systems</li> <li>- Identify and analyse social and ethical aspects in the specific design of artificial intelligence systems</li> </ul>	
	3 Cybersecurity	<p>Students are able to explain the key concepts and methods of cybersecurity, and can:</p> <ul style="list-style-type: none"> <li>- Define and analyse cybersecurity goals</li> <li>- Select and implement cryptographic methods appropriately</li> <li>- Examine implementations for accuracy</li> <li>- Identify and analyse social and ethical aspects in the specific design of a cybersecurity system</li> </ul>	20
<b>Restricted elective - choice of a specialist subject (elective subjects)</b>	4 Specialisation in Artificial Intelligence and Cybersecurity	<p>Students identify advanced concepts and methods of artificial intelligence and/or cybersecurity and can implement them in a practical manner in relevant fields of application.</p> <p>A list of courses relevant to the study at the University of Klagenfurt as well as at the University of Udine shall be prepared and updated annually.</p>	34
	5 Responsible Innovation	Students are able to identify the principles and methods of responsible innovation, in particular gender aspects, and can apply them in the area of artificial intelligence and cybersecurity.	8
<b>Unrestricted electives (optional subjects)</b>	6 Optional subjects	Students can choose from the full range of courses offered by the Universities of Klagenfurt and Udine and acquire additional skills accordingly.	6
<b>Master's thesis</b>	7 Master's thesis including exclusive tutorial and master seminar	Students are able to study complex questions in the area of artificial intelligence and/or cybersecurity according to the state of the art and to implement correct and ethical solutions.	26+2+2
		<b>Total:</b>	<b>120</b>

### Section 6 Semester abroad/mobility

It is advisable to obtain a "pre-recognition notice" according to Section 78 (6) UG from the Programme Director before beginning a period of study abroad.

## Section 7 Types of course

- (1) Lectures (German abbreviation VO) are courses in which knowledge is transferred by means of talks given by lecturers. The examination takes place as a one-off (written and/or oral) examination.
- (2) Courses with ongoing assessment are courses in which the assessment does not take place in a one-off examination, but on the basis of written and/or oral contributions by the participants. If, in the framework of a course with ongoing assessment, a seminar paper or a paper requiring a comparable degree of effort is to be written, papers for courses taking place in the winter semester can be handed in up until the following 30 June; papers for courses taking place in the summer semester can be handed in up until 31 January of the following year.
- (3) Courses with ongoing assessment comprise:
  - (a) Lecture with workshop (German abbreviation VC): This course consists of a lecture component and a workshop component, which have common taught content and are assessed together.
  - (b) Project (PR): In addition to scientific education and professional education and training, projects contribute to the practical and professional objectives of the degree programme. Particular emphasis is placed on working on real tasks and projects. A project study is a project in which small, applied research or development work is carried out in consideration of all necessary work steps, where appropriate as a team. A written assignment documenting the course of the project and its results is an inherent part of a project study.
  - (c) Seminar (SE): Seminars are used to reflect upon and discuss special scientific problems and/or work. Students make their own oral and written contributions, whereby written work must exhibit an independent academic character both in terms of form and content.
  - (d) Exclusive tutorial (German abbreviation PV): The purpose of the exclusive tutorial is to provide ongoing supervision and quality assurance to students as they write their Master's thesis.
- (4) In terms of courses from other curricula, the definitions found in the respective other curricula apply.

## Section 8 Courses for required subjects

Required subjects are subjects significant to the degree programme and for which examinations must be taken. The courses for the required subjects can be found in Table 2 below. A total of 42 ECTS credits must be obtained from required subjects.

**Table 2: Required subjects and assigned courses**

	Course title	Course type	ECTS credits
<b>Foundations of Artificial Intelligence and Cybersecurity</b>	1.1 Fundamentals of Artificial Intelligence and Cybersecurity	VC	4
	1.2 Social, Ethical and Legal Aspects of Artificial Intelligence and Cybersecurity	VC	4
	<b>Total:</b>		<b>8</b>
<b>Artificial Intelligence</b>	2.1 Introduction to Artificial Intelligence	VC	8
	2.2 Machine Learning and Deep Learning	VC	6
	<b>Total:</b>		<b>14</b>
<b>Cybersecurity</b>	3.1 Introduction to Cybersecurity	VC	8
	3.2 Verification and Validation for Artificial Intelligence and Cybersecurity <sup>1</sup>	VC	12
	<b>Total:</b>		<b>20</b>

### **Section 9 Courses for restricted electives (elective subjects)**

- (1) Restricted electives are subjects that students are able to select according to the regulations of the curriculum. A total of 42 ECTS credits are to be completed in elective subjects from the areas of Specialisation in Artificial Intelligence and Cybersecurity and Responsible Innovation. Of these, 34 ECTS credits must be selected from the area of Specialisation in Artificial Intelligence and Cybersecurity and 8 ECTS credits from the area of Responsible Innovation.
- (2) The courses, which are assigned to elective subjects, serve to deepen the knowledge, methods and skills in the (application) fields of Artificial Intelligence and Cybersecurity as well as Responsible Innovation. This includes technical applications as well as mathematical subjects. A list of relevant courses for the above-mentioned elective subjects, which take place at the Universities of Klagenfurt and Udine, shall be drawn up and updated annually and made public. The table below lists the courses that are offered in any case and are assigned to the above-mentioned elective subjects.
- (3) Projects, hereinafter referred to as "Small Project" and "Large Project" according to Tab. 3, points 4.5 and 4.6, are used for practical or research-oriented application or extension of the acquired knowledge and skills in the fields of artificial intelligence and cybersecurity. Projects can be completed as part of the restricted elective Specialisation in Artificial Intelligence and Cybersecurity. Students can choose the

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<sup>1</sup> This course is to be completed at the University of Udine.

subject area or topic of the project or choose from a number of suggestions. Before beginning the project, approval must be obtained from the supervisor.

- (4) A written report to document the content, results and experiences must be drawn up as part of the project. The supervising university lecturer evaluates the project on the basis of this report and a discussion.

**Table 3: Restrictive electives and assigned courses (LVs)**

	Course code	Course type	ECTS credits
<b>Specialisation in Artificial Intelligence and Cybersecurity</b>	4.1 Advanced Topics in Artificial Intelligence 1	VC	6
	4.2 Advanced Topics in Artificial Intelligence 2	VC	6
	4.3 Advanced Topics in Cybersecurity 1	VC	6
	4.4 Advanced Topics in Cybersecurity 2	VC	6
	4.5 Small Project in Artificial Intelligence and Cybersecurity	PR	12
	4.6 Large Project in Artificial Intelligence and Cybersecurity	PR	24
	Relevant courses	*2	*3
<b>Responsible Innovation</b>	5.1 Communicating Artificial Intelligence and Cybersecurity Research	SE	2
	5.2. Responsible Engineering of Artificial Intelligence and Cybersecurity Systems	SE	6
	5.3. Gender and Technology	*2	*3
	Relevant courses	*2	*3

## **Section 10 Unrestricted electives (optional subjects)**

- (1) Unrestricted electives are courses that can be freely chosen from a range of different course offerings at recognised domestic or international universities. Courses that the student completed in order to be entitled to study or to gain general or special university entrance qualifications are excluded from this. A total of 6 ECTS credits must be obtained from unrestricted electives.
- (2) In the case of courses that have been completed at other recognised domestic or international post-secondary educational institutions, the responsible university body will decide whether recognition as a unrestricted elective makes sense academically or with regard to professional activities for the chosen programme of study.

<sup>2</sup> Different types of courses are possible.

<sup>3</sup> Different ECTS credits are possible.

## **Section 11 Courses with a limited number of participants**

- (1) The maximum number of participants permitted on each of the following types of course is as follows:
  - Lecture with workshop (VC): 30, with the exception of the "Social, Ethical and Legal Aspects of Artificial Intelligence and Cybersecurity" course, with a maximum of 20 participants;
  - Project (PR): 15
  - Seminar (SE): 15, with the exception of the "Responsibility in Artificial Intelligence & Cybersecurity: Reflecting the social and ethical dimensions in the Master's thesis" course with a maximum of 10 participants;
  - Exclusive tutorial (PV): 15
- (2) For courses from other curricula, the maximum numbers found in the respective curricula apply.
- (3) Depending on the didactic requirements and the availability of spatial, budgetary and other resources, the Programme Director may determine maximum numbers of participants that deviate from this.
- (4) If the number of applications for these courses exceeds the number of places available, students will be accepted in accordance with the following procedure:
  - (a) Students for whom the course is a required subject or restricted elective in their curriculum are given priority.
  - (b) If the number of applications still exceeds the number of available places, the students are ranked based on the already acquired ECTS credits for the curriculum that stipulates the course in question as a required subject/restricted elective. A higher total is ranked higher.
  - (c) In addition, parallel courses are to be offered if necessary.

## **Section 12 Master's thesis**

- (1) The Master's thesis is the academic thesis that demonstrates the student's ability to achieve adequate standards of content and methodology when independently addressing scholarly topics. The assignment for the Master's thesis should be chosen in such a way that it is possible and reasonable to expect a student to complete it within six months. A number of students may jointly address a topic, provided that the performance of individual students can be assessed.
- (2) The subject of the Master's thesis must be chosen from the required subjects (with the exception of the subject "Foundations of Artificial Intelligence and Cybersecurity") or from the restricted electives (with the exception of the subject "Responsible Innovation").
- (3) The Master's thesis comprises 26 ECTS credits. In relation to the Master's thesis, the exclusive tutorial (2 ECTS credits) must be completed with the Master's thesis supervisor along with a reflection within the framework of the Master's seminar

"Responsibility in Artificial Intelligence & Cybersecurity: Reflecting the social and ethical dimensions in the master thesis" (2 ECTS credits).

- (4) The reflection drawn up within the framework of the Master's seminar in accordance with paragraph 3 shall be integrated into the Master's thesis. The seminar must be successfully completed before submission of the Master's thesis.
- (5) Pursuant to Part B, Section 18, Para. 4 and 2a of the University Statutes, the topic and the Master's thesis supervisor must be approved by the Rector of Studies. The application must be made prior to starting work. The student is permitted to change supervisor up until the time when the Master's thesis is submitted. A student's Master's thesis in the framework of the joint study programme with the University of Udine is supervised by a person authorised to supervise from each university.
- (6) The completed Master's thesis must be submitted to the Rector of Studies in electronic format. The Master's thesis must be assessed within two months of submission.

### **Section 13 Examination regulations**

- (1) Course examinations for lectures (VO) are - preferably in written form - sat at the end of or after the course as a single examination and cover the course material. The purpose is to assess how successfully students have participated in the course and to demonstrate the student's mastery of the knowledge, methods and skills gained in the lecture. In particular, the educational objectives defined in the competency profile (Section 2) must be used as a benchmark.
- (2) All other types of course have ongoing assessment; attendance is compulsory. Projects (PR) are assessed through accompanying checks and also through written and oral examinations as well as on the basis of practical activities. Students' written and oral contributions (especially seminar papers, presentations in seminars and participation in discussions) are used as a benchmark for assessment in seminars (SE) and exclusive tutorials (PV). In a lecture with workshop (VC), the mode of examination is to be determined based on the character of the course and the educational objectives.
- (3) The course instructors must provide information in a suitable manner about the contents, teaching methods and learning outcomes of their courses and the contents, methods, criteria of course assessment and examinations in the electronic course registration system (ZEUS) prior to the start of each semester (Section 76 (2) UG).
- (4) Examinations that have already been used for the completion of studies regarded as admission requirements cannot be used again to complete the programme of studies in the Master's degree programme.
- (5) To graduate from the Master's degree programme in *Artificial Intelligence and Cybersecurity*, students are required to successfully complete the following course components:
  - (a) The courses for the required subjects, both restricted electives and unrestricted electives;

- (b) The Master's thesis, the associated exclusive tutorial as well as the seminar in accordance with Section 12 (3);
  - (c) The final comprehensive oral examination held before an examination board according to Para. 6.
- (6) The prerequisite for applying for the comprehensive examination held before an examination board is the successful completion of the requirements listed under Para. 5, points (a) - (b). The comprehensive oral examination held before an examination board takes place in front of an examination board comprising at least three persons. In the case of the double degree programme, a representative from the University of Udine belongs to the examination board. The examination includes:
- (a) The subject that the topic of the Master's thesis falls under (in the form of a presentation and defence of the Master's thesis);
  - (b) The restricted elective Responsible Innovation;
  - (c) Another restricted elective that is different to lit. a) and b).
- (7) The regulations of the Statutes of the University of Klagenfurt, Part B and the Universities Act in their currently applicable version apply to the implementation and re-taking of examinations.

#### **Section 14 Entry into force**

This curriculum will enter into force as of 1 October 2020 following announcement in the University of Klagenfurt university bulletin and will apply to all students who commence their Master's degree programme from the 2020/21 winter semester onwards.

## APPENDIX Non-binding recommended route for orientation and planning purposes

The following tables suggest how the ECTS credits could be distributed across the semesters.

	1st semester	2nd semester	3rd semester	4th semester
1.1 Fundamentals of Artificial Intelligence and Cybersecurity	4 ECTS credits			
1.2 Social, Ethical and Legal Aspects of Artificial Intelligence and Cybersecurity	4 ECTS credits			
2.1 Introduction to Artificial Intelligence	8 ECTS credits			
2.2 Machine Learning and Deep Learning	6 ECTS credits			
3.1 Introduction to Cybersecurity	8 ECTS credits			
3.2 Verification and Validation for Artificial Intelligence and Cybersecurity		12 ECTS credits		
5.2. Responsible Engineering of Artificial Intelligence and Cybersecurity Systems		6 ECTS credits		
Choice of courses from restricted and unrestricted electives		12 ECTS credits		
Choice of courses from restricted and unrestricted electives/stay at partner university			30 ECTS credits	
Master's thesis				26 ECTS credits
Exclusive tutorial				2 ECTS credits
Responsibility in Artificial Intelligence & Cybersecurity: Reflecting the social and ethical dimensions in the master thesis				2 ECTS credits
<b>Total:</b>	<b>30 ECTS credits</b>	<b>30 ECTS credits</b>	<b>30 ECTS credits</b>	<b>30 ECTS credits</b>