UNIVERSITÄT KLAGENFURT

Curriculum

for the Bachelor's degree programme in

Robotics and Artificial Intelligence

Programme code UL 033 ...
(Version 22W.1)

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1 October 2022

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Contents

Section 1 General remarks

(1) The Bachelor's degree programme in Robotics and Artificial Intelligence provides 180 European Credit Transfer System credits (ECTS credits). This equates to an anticipated study duration of six semesters. The Bachelor's degree programme in Robotics and Artificial Intelligence is assigned to the group of Engineering Science degree programmes pursuant to Section 54, Para. 1 of the Austrian Universities Act 2002 (UG).

(2) The workload for the individual course units 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, Para. 2 UG). The workload comprises independent study as well as the semester hours/contact hours, including participation in assessment procedures.

(3) The Bachelor's degree programme is offered in English.

Section 2 Competency profile and skills

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

(2) **Initial situation**: The Bachelor's degree programme in Robotics and Artificial Intelligence (AI) provides students with knowledge and skills in the field of robotics and artificial intelligence. The aim is to enable graduates to work independently on complex tasks in this field and to prepare them for further study or a successful career in relevant industries. The areas of application for robotics and AI are diverse and, in some cases, are developing rapidly. From collaborative lightweight robots in the manufacturing industry and interventional or diagnostic robots in medicine to the use of drones in agriculture or space travel, the combination of traditional robotics with modern AI methods not only enables more efficient processes, but also creates entirely new fields of application in all sectors of the economy. In order for graduates to actively shape this dynamic environment, they are taught the necessary principles of physics, electrical engineering, computer science, mathematics and robotics, as well as the fundamentals of artificial intelligence and the applications of artificial intelligence in robotics.

(3) **Learning outcomes**: Graduates of this Bachelor's degree programme are able to understand and explain basic principles of robotics and artificial intelligence. They can identify areas of interest in these fields and select suitable approaches to solving them. To do this they combine basic knowledge from the fields of mathematics, physics, electrical engineering and computer science with methods from robotics and artificial intelligence. Graduates are also able to explain ethical and social aspects in the application of robotics and artificial intelligence and to apply this knowledge to practical cases. In the specialist modules, students can acquire further skills in the relevant fields of "Robotics & AI Applications", "Design and Modelling Tools for Robotics" and "Autonomous Systems and Networks". Gender knowledge and gender competencies can be acquired by attending courses in the restricted elective subject of Feminist Science/Gender Studies (Section 10).

(4) **Competencies**: Students acquire fundamental knowledge and practical skills through a broad range of subjects. The basis is formed by necessary interdisciplinary principles from physics (electricity, magnetism, mechanics, thermodynamics and kinematics), mathematics (linear algebra, analysis, stochastics and statistics), electrical engineering (digital circuits and circuit technology), computer science (operating systems, object-oriented programming, software engineering, networks), control engineering (systems theory and control engineering) and artificial intelligence (logic, symbolic AI, machine learning). These are complemented by subject-specific knowledge in robotics and the applications of artificial intelligence in robotics.

(5) **Professional fields and fields of activity**: Graduates of the Bachelor's degree programme in Robotics and Artificial Intelligence are professionals who are employed in small, medium and large companies and institutions. They can specify, plan, implement, manage and evaluate projects independently as well as in coordination with clients in a team. Graduates are needed in application areas such as automation, mobility, energy, digitalisation, health, agribusiness and in socio-political fields.

Section 3 Admission requirements

(1) The regulations of the UG concerning admission to the Bachelor's degree programme apply.

(2) For people whose first language is not English, English language knowledge is assumed to be at level B2 of the Common European Framework of Reference for Languages (CEFR).

Section 4 Academic degree

Graduates of this Bachelor's degree programme will be awarded the academic title "Bachelor" accompanied by the words "of Science" (abbreviated to BSc). If this title has been awarded, it must be used after the name.

Section 5 Structure and organisation of the degree programme/intended learning outcomes

Table 1: Structure of the Bachelor's degree programme

Subject/ course unit	**Subject designation**		**Intended learning outcomes**	**ECTS credits**
Required subjects	1	Robotics Engineering Fundamentals	Following successful completion of the subject, students will be able to: - Reflect on the choice of study with consideration for their professional future. - Understand and explain the principles of robotics and its application as well	**15.5**

			as measures for safe operation (safety). - Explain the most important concepts and laws of electricity and magnetism and apply them using specific examples. - Explain the most important concepts and laws of kinematics, dynamics and thermodynamics and apply them using specific examples.	
	2	Mathematics	Following successful completion of the subject, students will be able to: - Explain and apply basic concepts and methods of analysis, linear algebra, discrete mathematics, stochastics and the most important basic statistical skills.	**28**
	3	Computer Science and Software Development	Following successful completion of the subject, students will be able to: - Design and implement simple structured and object-based programs using development tools. - Plan, devise, implement, test and measure programs and software systems according to a development process. - Explain the components, organisation and working methods of modern computers and networks and implement them in examples. - Be familiar with important data structures and algorithms and evaluate them according to their algorithmic complexity. - Explain basic system security challenges and mitigating measures.	**22**
	4	Artificial Intelligence	Following successful completion of the subject, students will be able to: - Explain the essential concepts and methods of Artificial Intelligence. - Design Artificial Intelligence systems, identify and apply methods appropriate to specific Artificial Intelligence	**22.5**

			areas of interest and analyse the limitations of Artificial Intelligence systems. - Explain the theoretical principles of machine learning and apply them to practical examples. - Identify and analyse social and ethical aspects of Artificial Intelligence systems.	
	5	Information and Communications Engineering	Following successful completion of the subject, students will be able to: - Apply methods of circuit analysis. - Explain the functional principles of analogue and digital components and apply them in analogue and digital circuit design. - Use hardware description languages and analogue circuit simulators. - Apply methods for signal transformations and basic methods for the analysis of linear and time-invariant systems. - Explain concepts and techniques for transmitting signals and data over a communication channel. - Apply methods for measuring electrical and non-electrical quantities. - Select sensors and actuators for respective application purposes. - Explain and apply methods of systems theory to describe linear, time-invariant systems. - Apply control engineering concepts to analyse standard control loops and to size standard controllers.	**36**
	6	Bachelor's Thesis and Seminar	Following successful completion of the subject, students will be able to: - Define, plan, execute, document and present a task according to the rules of sound scientific engineering works.	**10**
Restricted electives	7	Labs Robotics & AI	Following successful completion of the subject, students will be able to:	**12**

			- Apply methods to practical areas of interest according to their own interests.	
	8	Specialisation	Following successful completion of the subject, students will be able to: - Explain in-depth knowledge and methods from the specialist topic according to their own interests and independently select and apply them according to the task at hand.	**24**
Free electives	9		Students acquire additional qualifications of their choice.	**10**
			Total:	**180**

Section 6 Orientation period

(1) In accordance with Section 66 of the Universities Act, the orientation period (StEOP) provides students with an overview of the key content of the degree programme and its further progression, and provides an objective basis for making decisions with regard to their choice of programmes of study.

(2) The StEOP takes place in the first semester. It comprises courses amounting to 12.5 ECTS credits and consists of the courses for the items listed in the required subjects 1.1 *Introduction to study*, 1.2 *Physics for Engineers*: *Kinematics, Dynamics and Thermodynamics* and 3.1 *Introduction to Structured and Object-based Programming*.

(3) Prior to completing the StEOP, additional courses worth up to 22 ECTS credits may be taken in accordance with Part B of the Statute, Section 14, Para. 7. According to Section 66, Para. 3 of the Universities Act, recognised examinations according to Section 78, other academic achievements, activities and qualifications are not to be included in this.

Section 7 Studying abroad/mobility

(1) It is strongly recommended that all students on the Bachelor's degree programme complete a study-related stay abroad as part of their degree. Transnational EU, state or university mobility programmes can be used for this purpose. Examinations and internships/other study achievements completed as part of a study-related stay abroad shall be recognized in accordance with the regulations pursuant to Section 78 of the Universities Act. The recommended mobility window is the third or fourth semester. It is also recommended that students complete a total of 30 ECTS credits during a one-semester stay abroad.

(2) At the request of degree students who wish to carry out parts of their studies abroad, it must be determined and confirmed in advance, which of the planned examinations and other academic achievements can be recognised (Section 78, Para. 5 UG). In all cases, students are encouraged to contact the appropriate Programme Director in advance regarding possible and intended recognition.

Section 8 Types of courses

(1) Lectures (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 Bachelor's thesis or seminar paper or a paper requiring a comparable degree of effort is to be written, it is possible to hand in the paper for courses taking place in the winter semester up until the following 30 June; for courses taking place in the summer semester, this is possible until 31 January of the following year.

(3) Courses with ongoing assessment comprise:

a) Lecture with workshop (VC): The lecture with workshop course type consists of a lecture component and a workshop component, which have common taught content and are assessed together. Phases in which knowledge is imparted through lectures by the lecturers alternate with phases in which lecturers and students work together on specific theoretical and practical issues.
b) Exercise class (UE): Exercises are courses in which students work on theoretical knowledge through specific tasks or areas of interest with the aim of practising and consolidating it (e.g. reinforcing the subject matter of the associated lecture, practising scientific methods, solving specific tasks, etc.).
c) Workshop (KS): Workshops are application-oriented or experience-oriented courses and help students acquire, build upon and consolidate academic as well as practical skills and give them the opportunity to work together with tutors on specific questions and learning content.
d) Lecture with exercise class (VU): The combined lecture with exercise class course type consists of a lecture component and an exercise component, which have common taught content and are assessed together.
e) Seminar (SE): A seminar is a research and theory-orientated course aimed at advanced students which encourages discussion of and reflection upon specific academic topics.
f) 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. Small practical research projects or development projects are conducted in teams, which include all of the necessary work steps.

Section 9 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 comprise 134 ECTS credits and can be found in the following table:

Table 2: Required subjects and assigned courses

	Course code		Course type	SHW	ECTS credits
1 Robotics Engineering Fundamentals	**1.1**	Introduction to the study (StEOP course)	VC	1	0,5
	1.2	Physics for Engineers: Kinematics, Dynamics and Thermodynamics (StEOP course)	VO + KS	2 + 2	4 + 2
	1.3	Physics for Engineers: Electricity and Magnetism	VO + KS	3 + 2	4 + 2
	1.4	Introduction to Robotics	VO	2	3
			Total:	**12**	**15,5**
2 Mathematics	**2.1**	Analysis 1 for Engineers	VO + UE	5 + 2	7,5 + 3
	2.3	Analysis 2 for Engineers	VO + UE	4 + 2	5 + 3
	2.4	Linear Algebra for Engineers	VO + UE	2,5 + 1	3 + 2
	2.5	Stochastics for Engineers	VC	3	4.5
			Total:	**19,5**	**28**
3 Computer Science and Software Development	**3.1**	Introduction to Structured and Object-based Programming (StEOP course)	VO + UE	2 + 2	2 + 4
	3.2	Software Engineering	VC	2	4
	3.3	Algorithms and Data Structures	VO + UE	2 + 2	2 + 4
	3.4	Operating Systems and Computer Networks	VO + UE	2 + 2	2 + 4
			Total:	**14**	**22**
4 Artificial Intelligence	**4.1**	Introduction to Artificial Intelligence I	VC	2	3
	4.2	Introduction to Artificial Intelligence II	VC	2	3
	4.3	Machine Learning	VC	2	4
	4.4	Responsible Robotics & AI: Ethics, Governance and Society	VC	2	4
	4.5	Symbolic Artificial Intelligence and Logic	VC	2	4
	4.6	Statistical Learning	VU	3	4,5
			Total:	**13**	**22,5**
5 Information and Communications Engineering	**5.1**	Design of Digital Circuits	VO + KS	2 + 2	3 + 3
	5.2	Circuit Engineering	VO + KS	2 + 2	3 + 3
	5.3	System Theory	VO + KS	2 + 2	3 + 3
	5.4	Communication Systems Engineering	VO + KS	2 + 2	3 + 3
	5.5	Measurement-, Sensor- and Actuator Technology	VO + KS	2 + 2	3 + 3
	5.6	Control Engineering	VO + KS	2 + 2	3 + 3
			Total:	**24**	**36**

6 Bachelor's Thesis and Seminar	**6.1**	Seminar	SE	2	3
	6.2	Project	PR	2	3
	6.3	Bachelor's Thesis			4
			Total:	**4**	**10**

Section 10 Courses for restricted electives

(1) Restricted electives are subjects that students are able to select according to the regulations of the curriculum. A total of 36 ECTS credits must be obtained from restricted electives. Courses amounting to 12 ECTS credits must be chosen from the restricted elective 7 and courses amounting to 24 ECTS credits from the restricted elective 8.

(2) The following content is taught in the specialist modules in restricted elective 8:

The specialist module **Robotics & AI Applications (see 8.1)** focuses on the possible applications of modern AI methods in robotics, teaching both theoretical principles and concepts for practical implementation. Topics addressed include computer vision (robotic vision), state estimation, simultaneous localization and mapping (SLAM), and AI-based control and path planning.

In the specialist module **Design & Modelling Tools for Robotics (see 8.2)**, additional knowledge in the field of microelectronics as well as the principles and practical application possibilities of simulation methods in robotics are taught. The focus is on numerical methods for the simulation of systems and relevant software tools as well as AI-based simulation methods such as system modelling with neural networks.

The specialist module **Autonomous Systems and Networks (see 8.3)** deals with concepts of (wireless) communication in decentralised (sensor) networks. In addition to basic communication protocols, current standards such as LTE and IEEE 802.11, and aspects of system security in networks, higher-level phenomena such as synchronisation and swarm behaviour are also covered.

The specialist module **Feminist Science/Gender Studies (see 8.4)** gives students the opportunity to enrich their technical knowledge with competencies from the fields of gender research. This comprises areas such as knowledge of hierarchical and discriminating processes, knowledge of gender naturalisation and normalisation, as well as other associated societal categories, and an understanding of discipline-specific methodologies and techniques for critical analysis.

(3) The restricted electives can be found in the table below:

Table 3: Restricted electives

			Course type	**ECTS credits**
7 Labs Robotics and AI	7.1	Choice of laboratory exercises from those offered by Information Technology and on Robotics & AI	KS	12

			Total:	**12**
8 Specialisation		Choice of 2 specialist modules[1]; choice of courses amounting to 12 ECTS credits		
	8.1	Robotics & AI Applications	VO/VC/UE/ KS	2 x 12
	8.2	Design and Modelling Tools for Robotics		
	8.3	Autonomous Systems and Networks		
	8.4	Feminist Science/Gender Studies		
			Total:	**24**

Section 11 Free electives

(1) Free 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 10 ECTS credits must be obtained from free 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 free elective makes sense academically or with regard to professional activities for the chosen programme of study.

Section 12 Courses with a limited number of participants

(1) The maximum number of participants permitted on each of the following courses is as follows:

- Workshop (KS) or Lecture with workshop (VC): 30 participants
- Workshop (KS) in the form of a laboratory with a traditional laboratory character; in particular when working with/on equipment in the laboratory is required: 12 participants
- Project (PR): 20 participants
- Seminar (SE): 20 participants
- Exercise classes (UE) or Lecture with exercise class (VU): 25 participants

(2) 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.

[1] Assignments of individual courses to specialist modules are made in the campus system by the Programme Director following consultation with the organisational units involved and the Curriculum Committee.

b) If the number of applications still exceeds the number of available places, the students are ordered 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.

(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.

Section 13 Bachelor's thesis

(1) A Bachelor's thesis is a piece of independent written work and is written in the context of completing degree programme requirements.

(2) A Bachelor's thesis is valued at 4 ECTS credits in addition to the course in which it is written. The Bachelor's thesis is to be written in addition to the two courses (seminar and project), which must be taken in the Bachelor's Thesis and Seminar subject, in the context of one of the two courses.

Section 14 Use of languages other than English

Courses as well as oral and written examinations of the Bachelor's degree programme are generally held in English. The Bachelor's thesis and other written work must be written in English.

Section 15 Examination regulations

(1) To graduate from the Bachelor's degree programme in Robotics and Artificial Intelligence, students are required to successfully complete the following course components:

a. The courses for the required subjects, restricted electives and free electives (Sections 9-11)
b. The Bachelor's thesis (Section 13)

(2) Lecture examinations take place at the end or after the lecture in the form of a one-off examination.

(3) All other types of course have ongoing assessment; attendance is compulsory.

(4) Pursuant to the Statute, the course lecturer must inform the students about the examination and evaluation methods for the course before each semester begins.

(5) The regulations of the Statute of the University of Klagenfurt and the Universities Act in their currently applicable version apply to the implementation and re-taking of examinations.

Section 16 Entry into force

This curriculum will enter into force after announcement in the University of Klagenfurt university bulletin as of 1 October 2022 and will apply to all students who commence their Bachelor's degree programme from the 2022/2023 winter semester onwards.

APPENDIX Non-binding recommended course of study

Semester 1	**Course type**	**ECTS credits**
1.1 Introduction to the study (StEOP)	VC	0,5
1.2 Physics for Engineers: Kinematics, Dynamics and Thermodynamics (StEOP)	VO + KS	4 + 2
1.3 Introduction to Robotics	VO	3
2.1 Analysis 1 for Engineers	VO + UE	7,5 + 3
3.1 Introduction to Structured and Object-Based Programming (StEOP)	VO + UE	2 + 4
4.4 Responsible Robotics & AI: Ethics, Governance and Society	VC	4
	Total:	**30**

Semester 2	**Course type**	**ECTS credits**
1.3 Physics for Engineers: Electricity and Magnetism	VO + KS	4 + 2
2.4 Linear Algebra for Engineers	VO + UE	3 + 2
2.3 Analysis 2 for Engineers	VO + UE	5 + 3
3.3 Algorithms and Data Structures	VO+UE	2 + 4
5.1 Design of Digital Circuits	VO + KS	3 + 3
	Total:	**31**

Semester 3	**Course type**	**ECTS credits**
2.5 Stochastics for Engineers	VC	4,5
4.1 Introduction to Artificial Intelligence I	VC	3
5.2 Circuit Engineering	VO + KS	3 + 3
5.3 System Theory	VO + KS	3 + 3
5.4 Communication Systems Engineering	VO + KS	3 + 3
7.1 Labs	KS	2 x 2
	Total:	**29,5**

Semester 4	**Course type**	**ECTS credits**
3.4 Operating Systems and Computer Networks	VO + UE	2 + 4
4.1 Introduction to Artificial Intelligence II	VC	3
4.5 Symbolic AI & Logic	VC	4
4.6 Statistical Learning	VU	4.5
5.6 Control Engineering	VO + KS	3 + 3
7.1 Labs	KS	2 x 2
8.x Specialisation		4
	Total:	**31,5**

Semester 5	**Course type**	**ECTS credits**
3.2 Software Engineering	VC	4
4.3 Machine Learning	VC	4
5.5 Measurement-, Sensor- and Actuator Technology	VO + KS	3 + 3
7.1 Labs	KS	2
8.x Specialisation		8
Free Electives		6
	Total:	**30**

Semester 6	**Course type**	**ECTS credits**
6.1 Seminar	SE	3
6.2 Project	PR	3
6.3 Bachelor's Thesis		4
7.1 Labs	KS	2
8.x Specialisation		12
Free Electives		4
	Total:	**28**