Curriculum for the Master's Degree Programme

Computer Science

Curriculum 2020

This curriculum was approved by the Senate of Graz University of Technology during its meeting on May 25, 2020.

The legal basis for this degree programme are the Universities Act (UG) and the Legal Regulations for Academic Affairs of the Statutes of Graz University of Technology, as amended.

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I General remarks

§ 1 Object of degree programme and the qualification profile

The Master's Degree Programme Computer Science is comprised of four semesters. The total scope of the degree programme is 120 ECTS credit points in accordance with § 54 (3) of the Universities Act (UG).

This Master's Degree Programme Computer Science is taught as a degree programme in the foreign language English in accordance with § 63a (8) of the Universities Act (UG).

Graduates of this degree programme are awarded the university degree of “Diplom-Ingenieurin”/“Diplom-Ingenieur”, abbreviated: “Dipl.-Ing.” or “DI”. The international equivalent of this university degree is “Master of Science”, abbreviated: “MSc”.

Object of degree programme

Computer Science deals with the basics, technologies and applications of systematic and automated information processing. It provides methods and tools for mastering complex systems in natural science, technology and other areas of human life, using both mathematical-formal and engineering approaches. In turn, findings from natural science and technology flow into computer science, and specific application problems can provide the impetus for the further development of computer science fundamentals.

Qualification profile and skills

a) Education and training objectives

Throughout the history of human activity, there has never been such a rapid growth in knowledge and the associated changes in knowledge as is now the case with information technologies. Graduates of the Master’s Degree Programme Computer Science have learned to deal with this phenomenon and to adjust to the need for independent and constant renewal of their knowledge. The Master’s Degree Programme Computer Science aims to provide a specialisation in selected topics while ensuring breadth and an interdisciplinary nature, and increases students’ independence and initiative in the way they think, decide and act. For this reason, the degree programme is designed to allow a great deal of freedom in the choice of teaching content.

A particular objective of this degree programme is therefore to develop the ability to think, decide and act in an interdisciplinary manner, and to develop an integrative approach to systems and therefore environmental and social issues, which are gaining in significance, especially with regard to increasing economic and social globalisation.

Information technologies contribute to globalisation of our world, and the English language is considered the lingua franca in this area. The English language is therefore a natural element of this degree programme, study periods abroad are encouraged, international doctoral candidates are integrated into the field of studies, and visiting professors from the international community enrich the degree programme considerably and contribute to the development of social competence. Projects, lecture activities,

written work and teamwork in groups further the development of the corresponding key competencies. Strategic thinking is developed as an integral element of the degree programme.

b) Learning outcomes

Graduates of the Master's Degree Programme Computer Science are prepared for these wide-ranging qualifications and are able to adapt more effectively to all areas of information technology in a shorter period of time than people with master's degrees from other degree programmes. Students of the Master's Degree Programme Computer Science have achieved the following goals by successfully completing the degree programme:

1) Knowledge and understanding

Graduates

- have developed an understanding of the relevant basics,
- are familiar with the key theories, principles and methods of information processing and information technology, and have deepened their knowledge considerably in two scientific fields of information processing and information technology,
- are familiar with the working methods of these areas and are able to apply these and the scientific principles in practice,
- know the most important strategies for solving problems and have developed the capacity for interdisciplinary analysis and assessment and the ability to justify and advocate solutions, and
- have acquired abstraction and analysis skills and the ability to think formally and algorithmically.

2) Acquiring knowledge

Graduates

- are able to apply theoretical knowledge of a technical and scientific nature in a practical way, and
- have developed the capacity for interdisciplinary analysis and assessment and the ability to justify and advocate solutions.

3) Transferable skills

Graduates

- are able to acquire new skills and work independently on research and development projects,
- have developed an awareness of the need for lifelong learning,
- are able to present the results in written and oral form and contribute to decision-making processes,
- have basic knowledge in the handling of projects,

- are able to integrate themselves into a team and independently take on subtasks and management functions and
- are capable of cross-border cooperation.

Differentiation from other degree programmes in the field of information and telecommunications

The Master's Degree Programme Computer Science is a theoretical and fundamental education with strong methodological and algorithmic components. In contrast, the Master's Degree Programme Software Engineering and Management is practice- and business-oriented. The Master's Degree Programme Information and Computer Engineering is designed as a generalist degree programme, in which a strong focus on hardware plays a role alongside software, thus acting as a link between Computer Science and Electrical Engineering. The Master's Degree Programme Mathematics has a strongly formal and theoretical character and focuses on basic mathematical theories, methods and models. Based on this consideration, the Master's Degree Programme Computer Science is thus somewhere between Mathematics on the one hand and Software Engineering and Management or Information and Computer Engineering on the other.

Need and relevance of the degree programme for science and for the labour market

Due to their theoretical and basic knowledge, graduates of the Master's Degree Programme Computer Science are able to think abstractly and model-oriented. This enables them to master complex systems in natural sciences, technology and other areas of human life. The acquired knowledge and the methodical-structured procedure learned enable a broad application in industry, economy and science.

II General provisions

§ 2 Admission requirements

(1) Admission to a master's degree programme requires the completion of a subject-related bachelor's degree programme or a subject-related bachelor's degree programme at a university of applied sciences or another equivalent degree programme at a recognised national or international post-secondary educational institution (§ 64 (3) of the Universities Act UG).

(2) The Master's Degree Programme Computer Science builds upon the content of the Bachelor's Degree Programme Computer Science of Graz University of Technology. In addition to this, the following preparatory studies are eligible for admission to the Master's Degree Programme Computer Science without further requirements:

- Bachelor's Degree Programme Software Engineering and Management of Graz University of Technology
- Bachelor's Degree Programme Information and Computer Engineering of Graz University of Technology

(3) In the case of other degree programmes, if equivalence with a subject-related degree programme (§ 2) is generally given and only individual additions to full equivalence are missing, additional courses and examinations from the Bachelor's Degree Programme Computer Science may be prescribed to the extent of a maximum of 30 ECTS credit points in order to achieve full equivalence. The recognition of these additional achievements to be obtained is permitted for free-choice courses up to an amount of 5 ECTS.

(4) In order to achieve a total of 300 ECTS credit points in the consecutive degree programmes, the assignment of one and the same course in both the bachelor's degree programme entitling to admission and the master's degree programme in question is excluded.

§ 3 Allocation of ECTS credit points

ECTS credit points are allocated to all achievements to be completed by the students. These ECTS credit points are used to determine the relative share of the workload associated with each study achievement, whereby the workload of one year must be 1500 real hours, and 60 ECTS credit points are allocated to this workload (corresponding to 25 real hours per ECTS credit point). The workload includes both the share of self-study and the semester course hours. One semester course hour corresponds to 45 minutes per teaching week of the semester.

§ 4 Structure of the degree programme

The Master's Degree Programme Computer Science with a workload of 120 ECTS credit points covers four semesters and is structured in modules, as follows: It is comprised of

1. a major with 60 ECTS credit points,
2. a minor with 24 ECTS credit points,
3. a free-choice subject that encompasses free-choice courses with a workload of 6 ECTS credit points, and
4. of a master's thesis. The master's thesis corresponds to 30 ECTS credit points and must be allocated to the major according to § 4.1.

One or more seminars and/or projects with a minimum of 10 ECTS credit points and a maximum of 15 ECTS credit points must be completed, of which at least 10 ECTS credit points are to be taken from the major module group.

	ECTS
Major from the module groups A-J (with 10-15 ECTS allocated to seminars/projects)	60
Minor from the module groups A-M	24
Recommended free-choice courses	6
Master's thesis	30
Total	120

§ 5 Types of courses

The types of courses offered at Graz University of Technology are governed by § 4 of the Excerpt of Statutes of Graz University of Technology, Legal Regulations for Academic Affairs (cf. Annex IV).

§ 6 Group size

The following maximum number of participants (group sizes) is set:

Lecture (VO) Lecture part of VU Orientation course (OL)	no restriction
Exercise (UE) Lecture part of VU	25 25
Laboratory course (LU)	6
Seminar (SE) Project (PT) Seminar project (SP)	15 15 15

§ 7 Guidelines for the allocation of places on courses

(1) If the number of students exceeds the number of available places, parallel courses are to be provided. If necessary, these parallel courses may also be provided during the holidays and semester breaks.

(2) If it is not possible to offer a sufficient number of parallel courses (groups), the students are to be admitted to the course according to the following priority ranking:

a. This course is a compulsory part of the curriculum for the student.

b. The total number of courses successfully completed in the relevant degree programme (total ECTS credit points).

c. The date (priority of earlier date) of fulfilment of the participation requirement.

d. Students who have already been deferred once or who have to repeat the course are to be given preferential admission to the next course to be held.

e. The grade of the examination or the grade average of the examinations (weighted on the basis of the ECTS credit points) - on the course(s) of the participation requirement.

f. Students who do not need to take such courses to complete the curriculum are only considered in terms of available places; they may be included in a separate replacement list. The abovementioned provisions apply mutatis mutandis.

(3) Students who complete a part of their studies at Graz University of Technology in the context of mobility programmes are given priority for up to 10% of the available places.

III Course content and structure

§ 8 Modules, courses and semester allocation

The individual courses of this master's degree programme and their structure are listed below. Students must choose one module group from the module groups A-J in the table below as major and one module group from the module groups A-M in the table below as minor. The module group selected for the major cannot be chosen as minor.

In the major, the compulsory modules “Compulsory 1” and “Compulsory 2” need to be completed in their entirety. Further courses for ECTS credit points may be selected from the elective module catalogues of the module group. In addition, up to 4 ECTS may be selected from the elective module N “Science, Technology and Society”. A total of 60 ECTS credit points is to be completed in the major.

In the minor, the compulsory module “Compulsory 1” needs to be completed in its entirety. Further ECTS credit points may be selected from up to four elective module catalogues of the module group and from the compulsory module "Compulsory 2". A total of 24 ECTS credit points is to be completed in the minor.

If a course is in a compulsory module of the chosen major and in the compulsory module “Compulsory 1” of the chosen minor, a course from the chosen minor's catalogue of elective modules with the same or higher ECTS credit points must be chosen instead.

Courses already credited for a bachelor’s degree programme may not be credited again for a compulsory module. In such case, they are to be replaced by any courses from the elective module catalogues of the respective module group to the same extent of ECTS credit points.

The elective module catalogues of the module groups are specified in § 9. The description of the knowledge, methods or skills to be taught in the modules are described in more detail in Annex I. The allocation of courses to specific semesters is a recommendation and ensures that the sequence of courses builds optimally on previous knowledge and that the workload of an academic year does not exceed 60 ECTS credit points. The fourth semester is dedicated to the writing of the master's thesis.

Master's Degree Programme Computer Science, module groups								
Module	**Course**	**SSt**	**Course Type**	**ECTS**	**Semester with ECTS credit points I**	**II**	**III**	**IV**
Module group A: Algorithms and Theoretical Computer Science								
Compulsory module A1: Algorithms and Theoretical Computer Science – Compulsory 1 (major and minor)								
A1.1	Enumerative Combinatoric Algorithms	2	VU	3.5		3.5		
A1.2	Discrete Stochastics and Information Theory (Computer Science)	3	VO	4.5		4.5		
A1.3	Discrete Stochastics and Information Theory	1	UE	1		1		
Subtotal compulsory module A1		**6**		**9**		**9**		
Compulsory module A2: Algorithms and Theoretical Computer Science – Compulsory 2 (major)								
A2.1	Discrete and Computational Geometry	3	VO	4.5	4.5			
A2.2	Discrete and Computational Geometry	1	UE	1.5	1.5			
A2.3	Combinatorial Optimisation 1	4	VO	6	6			
A2.4	Combinatorial Optimisation 1	1	UE	1.5	1.5			
Subtotal compulsory module A2		**9**		**13.5**	**13.5**			
as minor								
Total compulsory modules A (minor)		**6**		**9**				
Elective modules A3-A7				**15**				
Subtotal Algorithms and Theoretical Computer Science (minor)				**24**				
as major								
Total compulsory modules A (major)		**15**		**22.5**				
Elective modules A3-A7				**37.5**				
Subtotal Algorithms and Theoretical Computer Science (major)				**60**				
Module group B: Data Science								
Compulsory module B1: Data Science – Compulsory 1 (major and minor)								
B1.1	Knowledge Discovery & Data Mining 1	2	VO	3		3		
B1.2	Knowledge Discovery & Data Mining 1	1	KU	1.5		1.5		
B1.3	Data Integration and Large-Scale Analysis	3	VU	5	5			
Subtotal compulsory module B1		**6**		**9.5**	**5**	**4.5**		
Compulsory module B2: Data Science – Compulsory 2 (major)								
B2.1	Architecture of Machine Learning Systems	3	VU	5		5		
B2.2	Data Analysis and Introduction to R	2	VO	3	3			
B2.3	Data Analysis and Introduction to R	1	UE	2	2			
Subtotal compulsory module B2		**6**		**10**	**5**	**5**		
as minor								
Total compulsory modules B (minor)		**6**		**9.5**				
Elective modules B3-B7				**14.5**				
Subtotal Algorithms and Theoretical Computer Science (minor)				**24**				

Module	Course	SSt	Course Type	ECTS	Semester with ECTS credit points I	II	III	IV
Master's Degree Programme Computer Science, module groups								
as major								
Total compulsory modules B (major)		**12**		**19.5**				
Elective modules B3-B7				**40.5**				
Subtotal Algorithms and Theoretical Computer Science (major)				**60**				
Module group C Games Engineering								
Compulsory module C1: Games Engineering – Compulsory 1 (major and minor)								
C1.1	Game Design and Development	3	VU	5	5			
C1.2	Real-Time Graphics	2	VO	3	3			
C1.3	Real-Time Graphics	1	KU	2	2			
Subtotal compulsory module C1		**6**		**10**	**10**			
Compulsory module C2: Games Engineering – Compulsory 2 (major)								
C2.1	Game Design and Development II	3	VU	5		5		
C2.2	Simulation and Animation	3	VU	5		5		
Subtotal compulsory module C2		**6**		**10**		**10**		
as minor								
Total compulsory modules C (minor)		**6**		**10**				
Elective modules C3-C6				**14**				
Subtotal Algorithms and Theoretical Computer Science (minor)				**24**				
as major								
Total compulsory modules C (major)		**12**		**20**				
Elective modules C3-C6				**40**				
Subtotal Algorithms and Theoretical Computer Science (major)				**60**				
Module group D: Information Security								
Compulsory module D1: Information Security – Compulsory 1 (major and minor)								
D1.1	Secure Software Development	2	VO	3	3			
D1.2	Secure Software Development	1	KU	2	2			
D1.3	Cryptography	2	VO	3	3			
D1.4	Cryptography	1	KU	2	2			
Subtotal compulsory module D1		**6**		**10**	**10**			
Compulsory module D2: Information Security – Compulsory 2 (major)								
D2.1	Verification and Testing	2	VO	3	3			
D2.2	Verification and Testing	1	UE	2	2			
D2.3	Secure Application Design	2	VO	3		3		
D2.4	Secure Application Design	1	KU	2		2		
Subtotal compulsory module D2		**6**		**10**	**5**	**5**		
as minor								
Total compulsory modules D (minor)		**6**		**10**				

Master's Degree Programme Computer Science, module groups

Module	Course	SSt	Course Type	ECTS	Semester with ECTS credit points I	II	III	IV
Elective modules D1-D7				**14**				
Subtotal (minor)				**24**				
			as major					
Total compulsory modules D (major)		**12**		**20**				
Elective modules D3-D7				**40**				
Subtotal (major)				**60**				
			Module group E: Intelligent Systems					
Compulsory module E1: Intelligent Systems – Compulsory 1 (major and minor)								
E1.1	Intelligent Systems	2	VO	3		3		
E1.2	Intelligent Systems	1	KU	2		2		
E1.3	Knowledge Discovery & Data Mining 1	2	VO	3		3		
E1.4	Knowledge Discovery & Data Mining 1	1	KU	1.5		1.5		
Subtotal compulsory module E1		**6**		**9.5**		**9.5**		
Compulsory module E2: Intelligent Systems – Compulsory 2 (major)								
E2.1	Natural Language Processing	3	VU	5		5		
E2.2	Intelligent User Interfaces	3	VU	5		5		
Subtotal compulsory module E2		**6**		**10**		**10**		
			as minor					
Total compulsory modules E (minor)		**6**		**9.5**				
Elective modules E3-E7				**14.5**				
Subtotal (minor)				**24**				
			as major					
Total compulsory modules E (major)		**12**		**19.5**				
Elective modules E3-E7				**40.5**				
Subtotal (major)				**60**				
			Module group F: Interactive and Visual Information Systems					
Compulsory module F1: Interactive and Visual Information Systems – Compulsory 1 (major and minor)								
F1.1	Designing Interactive Systems	2	VU	3		3		
F1.2	Digital Libraries	2	VU	3.5	3.5			
F1.3	Information Search and Retrieval	3	VU	5	5			
Subtotal compulsory module F1		**7**		**11.5**	**8.5**	**3**		
Compulsory module F2: Interactive and Visual Information Systems – Compulsory 2 (major)								
F2.1	Web Technology	3	VU	5	5			
F2.2	Evaluation Methodology	2	VU	3	3			
Subtotal compulsory module F2		5		**8**	**8**			
			as minor					
Total compulsory modules F (minor)		**7**		**11.5**				

Master's Degree Programme Computer Science, module groups								
Module	**Course**	**SSt**	**Course Type**	**ECTS**	**Semester with ECTS credit points I**	**II**	**III**	**IV**
Elective modules F3-F6				**12.5**				
Subtotal (minor)				**24**				
			as major					
Total compulsory modules F (major)		**12**		**19.5**				
Elective modules F3-F6				**40.5**				
Subtotal (major)				**60**				
Module group G: Machine Learning								
Compulsory module G1: Machine Learning – Compulsory 1 (major and minor)								
G1.1	Machine Learning 2	2	VO	3		3		
G1.2	Machine Learning 2	1	KU	2		2		
G1.3	Deep Learning	2	VO	3	3			
G1.4	Deep Learning	1	KU	2	2			
Subtotal compulsory module G1		**6**		**10**	**5**	**5**		
Compulsory module G2: Machine Learning – Compulsory 2 (major)								
G2.1	Autonomously Learning Systems	2	VO	3	3			
G2.2	Autonomously Learning Systems	1	KU	2	2			
Subtotal compulsory module G2		**3**		**5**	**5**			
			as minor					
Total compulsory modules G (minor)		**6**		**10**				
Elective modules G3-G7				**14**				
Subtotal (minor)				**24**				
			as major					
Total compulsory modules G (major)		**9**		**15**				
Elective modules G3-G7				**45**				
Subtotal (major)				**60**				
Module group H: Robotics								
Compulsory module H1: Robotics – Compulsory 1 (major and minor)								
H1.1	Advanced Robotics	2	VO	3		3		
H1.2	Advanced Robotics	1	LU	2		2		
H1.3	Mobile Robots	2	VO	3	3			
H1.4	Mobile Robots	1	UE	2	2			
Subtotal compulsory module H1		**6**		**10**	**5**	**5**		
Compulsory module H2: Robotics – Compulsory 2 (major)								
H2.1	Intelligent Systems	2	VO	3		3		
H2.2	Intelligent Systems	1	KU	2		2		
H2.3	Robot Vision	2	VO	3		3		
H2.4	Robot Vision	1	KU	2		2		
Subtotal compulsory module H2		**6**		**10**		**10**		

Master's Degree Programme Computer Science, module groups								
Module	Course	SSt	Course Type	ECTS	Semester with ECTS credit points I	II	III	IV
as minor								
Total compulsory modules H (minor)		**6**		**10**				
Elective modules H3-H8				**14**				
Subtotal (minor)				**24**				
as major								
Total compulsory modules H (major)		**12**		**20**				
Elective modules H3-H8				**40**				
Subtotal (major)				**60**				
Module group I: Software Technology								
Compulsory module I1: Software Technology – Compulsory 1 (major and minor)								
I1.1	Software Technology	3	VU	5		5		
I1.2	Compiler Construction	2	VO	3		3		
I1.3	Compiler Construction	1	KU	2		2		
Subtotal compulsory module I1		**6**		**10**		**10**		
Compulsory module I2: Software Technology – Compulsory 2 (major)								
I2.1	Design Patterns	2	VO	3	3			
I2.2	Design Patterns	1	UE	1.5	1.5			
I2.3	Verification and Testing	2	VO	3	3			
I2.4	Verification and Testing	1	UE	2	2			
Subtotal compulsory module I2		**6**		**9.5**	**9.5**			
as minor								
Total compulsory modules I (minor)		**6**		**10**				
Elective modules I3-I8				**14**				
Subtotal (minor)				**24**				
as major								
Total compulsory modules I (major)		**12**		**19.5**				
Elective modules I3-I8				**40.5**				
Subtotal (major)				**60**				
Module group J: Visual Computing								
Compulsory module J1: Visual Computing – Compulsory 1 (major and minor)								
J1.1	Geometric 3D-Modelling in Computer Graphics	3	VU	5		5		
J1.2	Image Processing and Pattern Recognition	2	VO	3	3			
J1.3	Image Processing and Pattern Recognition	1	KU	2	2			
Subtotal compulsory module J1		**6**		**10**	**5**	**5**		
Compulsory module J2: Visual Computing – Compulsory 2 (major)								
J2.1	Real-Time Graphics	2	VO	3	3			
J2.2	Real-Time Graphics	1	KU	2	2			

Master's Degree Programme Computer Science, module groups								
Module	Course	SSt	Course Type	ECTS	Semester with ECTS credit points I	II	III	IV
J2.2	Robot Vision	2	VO	3		3		
J2.3	Robot Vision	1	KU	2		2		
Subtotal compulsory module J2		**6**		**10**	**5**	**5**		
			as minor					
Total compulsory modules J (minor)		**6**		**10**				
Elective modules J3-J7				**14**				
Subtotal (minor)				**24**				
			as major					
Total compulsory modules J (major)		**12**		**20**				
Elective modules J3-J7				**40**				
Subtotal (major)				**60**				
Module group K: Supplementary Mathematical Foundations								
Compulsory module K1: Supplementary Mathematical Foundations – Compulsory 1								
K1.1	Technical Numerics	2	VO	3	3			
K1.2	Technical Numerics	2	UE	4	4			
Subtotal compulsory module K1		**4**		**7**	**7**			
			only selectable as minor					
Total compulsory modules K (minor)		**4**		**7**				
Elective modules K2-K7 (minor)				**17**				
Subtotal (minor)				**24**				
Module group L: Supplementary Statistics								
Compulsory module L1: Supplementary Statistics – Compulsory 1								
L1.1	Applied Statistics	3	VO	4	4			
L1.2	Applied Statistics	1	UE	2	2			
Subtotal compulsory module L1		**4**		**6**	**6**			
			only selectable as minor					
Total compulsory modules L (minor)		**4**		**6**				
Elective modules L2-L6				**18**				
Subtotal (minor)				**24**				
Module group M: Supplementary Embedded and Mobile Systems								
Compulsory module M1: Supplementary Embedded and Mobile Systems – Compulsory 1								
M1.1	Embedded Systems	2	VO	3		3		
M1.2	Embedded Systems, Laboratory	1	LU	1.5		1.5		
Subtotal compulsory module M1		**3**		**4.5**				

Master's Degree Programme Computer Science, module groups							
Module	Course	SSt	Course Type	ECTS	Semester with ECTS credit points I	II	III	IV
only selectable as minor								
Total compulsory modules M (minor)		**3**		**4.5**				
Elective modules M2-M7				**19.5**				
Subtotal (minor)				**24**				

§ 9 Elective modules

Elective modules with a selection of courses are defined for each module group. Courses already credited for a bachelor's degree programme may not be credited again for an elective module.

In the following elective module catalogues, recommended courses are marked with the superscript letter[e]. These are bachelor-level courses that impart the basics for the module. They are therefore recommended if they have not yet been completed in a bachelor's degree programme. Courses that are held in German (DE) only are marked with the superscript letters[DE].

(1) Elective module catalogues Algorithms and Theoretical Computer Science

Elective module A3: Algorithms and Theoretical Computer Science – Algorithms					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Design and Analysis of Algorithms[e,DE]	3	VU	5	*5*	
Problem Analysis and Complexity Theory	3	VU	4.5		*4.5*
Algorithms and Games	1.5	VU	2	*2*	
Probabilistic Method in Combinatorics and Algorithmics	3	VU	4.5	*4.5*	
Advanced and Algorithmic Graph Theory	3	VO	4.5		*4.5*
Advanced and Algorithmic Graph Theory	1	UE	1.5		*1.5*
Geometry for Computer Scientists	2	VU	3	*3*	

Elective module A4: Algorithms and Theoretical Computer Science – Optimisation					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Numerical Optimisation[e]	3	VO	4.5	*4.5*	
Numerical Optimisation[e]	2	UE	2.5	*2.5*	
Convex Optimisation	3	VU	5		*5*
Operations Research	3	VO	4.5	*4.5*	
Operations Research	1	UE	2	*2*	
Combinatorial Optimisation 2	3	VO	4.5		*4.5*
Combinatorial Optimisation 2	1	UE	1.5		*1.5*

Elective module A5: Algorithms and Theoretical Computer Science – Theoretical Computer Science					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Theoretical Computer Science[e,DE]	2	VO	3		*3*
Theoretical Computer Science[e,DE]	1	KU	1		*1*
Logic and Computability[e]	2	VO	3		*3*
Logic and Computability[e]	1	KU	1		*1*
Information Theory and Coding	2	VO	3	*3*	
Information Theory and Coding	1	UE	2	*2*	
Analytic Combinatorics	3	VU	4.5		*4.5*
Complexity Theory	3	VO	4.5	*4.5*	
Complexity Theory	1	UE	1	*1*	

Elective module A6: Algorithms and Theoretical Computer Science – Applications					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Machine Learning 1	2	VO	3		*3*
Machine Learning 1	1	KU	1.5		*1.5*
Mathematical Principles in Visual Computing	3	VU	5		*5*
Network Science	3	VU	5	*5*	
Verification and Testing	2	VO	3	*3*	
Verification and Testing	1	UE	2	*2*	
Number Theory	3	VO	4.5	*4.5*	
Number Theory	1	UE	1.5	*1.5*	
Model Checking	2	VO	3		*3*
Model Checking	1	UE	2		*2*
Formal Specification and Design of Software	3	VU	5	*5*	

Elective module A7: Algorithms and Theoretical Computer Science – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Algorithms	4	SP	10	*10*	*10*
Seminar (Discrete Mathematics and Theory of Algorithms)	2	SE	3.5		*3.5*
Seminar Algorithm Design 1	3	SE	5	*5*	
Seminar Algorithm Design 2	3	SE	5		*5*
Seminar Theoretical Computer Science	3	SE	5		*5*

[DE]: This course is offered in German only.
[e]: Recommended course, unless it was already completed in the bachelor's degree programme.

(2) Elective module catalogues Data Science

Elective module B3: Data Science – Data Mining and Machine Learning					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Knowledge Discovery & Data Mining 2	3	VU	5	*5*	
Machine Learning 1[e]	2	VO	3		*3*
Machine Learning 1[e]	1	UE	1.5		*1.5*

Elective module B3: Data Science – Data Mining and Machine Learning

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Machine Learning 2	2	VO	3		*3*
Machine Learning 2	1	KU	2		*2*
Numerical Optimisation	3	VO	4.5	*4.5*	
Numerical Optimisation	2	UE	2.5	*2.5*	
Deep Learning	2	VO	3	*3*	
Deep Learning	1	KU	2	*2*	
Visual Analytics	3	VU	5		*5*

Elective module B4: Data Science – Data Management

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Architecture of Database Systems	3	VU	5	*5*	
Spatial Databases	2	VU	3	*3*	
Privacy Enhancing Technologies	2	VO	3	*3*	
Privacy Enhancing Technologies	1	KU	2	*2*	

Elective module B5: Data Science – Social Data Science

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Computational Social Systems 1	3	VU	5		*5*
Computational Social Systems 2	3	VU	5	*5*	
Network Science	3	VU	5	*5*	
Natural Language Processing	3	VU	5		*5*
Recommender Systems	2	VU	3		*3*
Information Search and Retrieval	3	VU	5	*5*	
Social Media Technologies	2	VU	3		*3*
Evaluation Methodology	2	VU	3	*3*	
Critical Readings in Data Science 1	2	UE	4	*4*	
Critical Readings in Data Science 2	2	UE	4		*4*

Elective module B6: Data Science – Statistics

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Industrial Statistics	3	VO	4		*4*
Industrial Statistics	1	UE	2		*2*
Statistics[DE]	3	VO	4	*4*	
Statistics[DE]	1	UE	2	*2*	
Topological Data Analysis	3	VU	5		*5*

Elective module B7: Data Science – Projects and Seminars

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Data Science	4	SP	10	*10*	*10*
Seminar Data Science	3	SE	5	*5*	*5*

[DE]: This course is offered in German only.
[e]: Recommended course, unless it was already completed in the bachelor's degree programme.

(3) Elective module catalogues Games Engineering

Elective module C3: Games Engineering – Algorithms and Software Technologies					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Algorithms and Games[e]	1.5	VU	2	*2*	
Advanced Topics in Artificial Intelligence	2	VO	3	*3*	
Advanced Topics in Artificial Intelligence	1	UE	2	*2*	
Mobile Applications	3	VU	5		*5*
GPU Programming	3	VU	5		*5*
Software Technology	3	VU	5		*5*

Elective module C4: Games Engineering – Human Computer Interaction					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Designing Interactive Systems	2	VU	3		*3*
HCI: Applying User-Centred Design	3	VU	4.5		*4.5*
Information Architecture and Web Usability	3	VU	5	*5*	
Social Media Technologies	2	VU	3		*3*
User Interfaces	1.5	VU	2		*2*
Intelligent User Interfaces	3	VU	5		*5*
Evaluation Methodology	2	VU	3	*3*	

Elective module C5: Games Engineering – Visual Computing and Virtual Experiences					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Augmented Reality	3	VU	5	*5*	
Virtual Reality	4	VU	7		*7*
3D Computer Graphics and Realism	3	VU	5	*5*	
Geometric 3D-Modelling in Computer Graphics	3	VU	5		*5*
Mathematical Principles in Visual Computing	3	VU	5		*5*

Elective module C6: Games Engineering – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Games Engineering	4	SP	10	*10*	*10*
Application of Innovative Technologies	2	SE	5	*5*	*5*
Instructional Design in (Game-Based) Learning	2	SE	3		*3*
Mobile Game Engineering	3	SE	5		*5*

[e]: Recommended course, unless it was already completed in the bachelor's degree programme.

(4) Elective module catalogues Information Security

Elective module D3: Information Security – Cryptology & Privacy

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Cryptanalysis	2	VO	3		*3*
Cryptanalysis	1	KU	2		*2*
Privacy Enhancing Technologies	2	VO	3	*3*	
Privacy Enhancing Technologies	1	KU	2	*2*	
Problem Analysis and Complexity Theory	3	VU	4.5		*4.5*
Coding and Cryptography	3	VO	4.5		*4.5*
Coding and Cryptography	1	UE	1.5		*1.5*

Elective module D4: Information Security – System Security

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Digital System Integration and Programming	3	VU	5	*5*	
Side-Channel Security	3	VU	5		*5*
Digital System Design	2	VO	3		*3*
Digital System Design	1	KU	2		*2*
Cloud Operating Systems	3	VU	5		*5*
Compiler Construction	2	VO	3		*3*
Compiler Construction	1	KU	2		*2*

Elective module D5: Information Security – Formal Methods for Security

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Model Checking	2	VO	3		*3*
Model Checking	1	UE	2		*2*
Model-Based Testing	3	VU	5	*5*	
Formal Specification and Design of Software	3	VU	5	*5*	
Logic and Computability[e]	2	VO	3		*3*
Logic and Computability[e]	1	KU	1.5		*1.5*
Discrete Stochastics and Information Theory (Computer Science)	3	VO	4.5		*4.5*
Discrete Stochastics and Information Theory	1	UE	1		*1*

Elective module D6: Information Security – Secure Applications

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Mobile Security	2	VO	3		*3*
Mobile Security	1	KU	2		*2*
Secure Product Lifecycle	2	VO	3	*3*	
Secure Product Lifecycle	1	KU	2	*2*	
Introduction into ICT-Law[KFU, DE]	2	VO	3	*3*	
Fault-Tolerant Distributed Algorithms	2	VU	3	*3*	
Knowledge Discovery & Data Mining 1	2	VO	3		*3*
Knowledge Discovery & Data Mining 1	1	KU	1.5		*1.5*

Elective module D7: Information Security – Projects and Seminars

Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Information Security	4	SP	10	*10*	*10*

Elective module D7: Information Security – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar Cryptology and Privacy	2	SE	3.5	*3.5*	*3.5*
Seminar Formal Methods	2	SE	3.5	*3.5*	

DE: This course is offered in German only.
e: Recommended course, unless it was already completed in the bachelor's degree programme.

(5) Elective module catalogues Intelligent Systems

Elective module E3: Intelligent Systems – Artificial Intelligence					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Basics in Artificial Intelligence and Logic[e,DE]	2	VU	3		*3*
Advanced Topics in Artificial Intelligence	2	VO	3	*3*	
Advanced Topics in Artificial Intelligence	1	UE	2	*2*	
Configuration Systems	2	VU	3	*3*	

Elective module E4: Intelligent Systems – Data Mining and Machine Learning					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Knowledge Discovery & Data Mining 2	3	VU	5	*5*	
Machine Learning 1[e]	2	VO	3		*3*
Machine Learning 1[e]	1	UE	1.5		*1.5*
Deep Learning	2	VO	3	*3*	
Deep Learning	1	KU	2	*2*	
Principles of Brain Computation	2	VO	3		*3*
Principles of Brain Computation	1	KU	2		*2*
Adaptive Systems	2	VO	3	*3*	
Adaptive Systems	1	UE	2	*2*	
Data Analysis and Introduction to R	2	VO	3	*3*	
Data Analysis and Introduction to R	1	UE	2	*2*	

Elective module E5: Intelligent Systems – Robotics					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Advanced Robotics	2	VO	3		*3*
Advanced Robotics	1	LU	2		*2*
Context-Aware Computing	2	VO	3	*3*	
Context-Aware Computing	1	UE	1.5	*1.5*	
Mobile Robots	2	VO	3	*3*	
Mobile Robots	1	UE	2	*2*	
Navigation Systems	2	VU	3	*3*	

Elective module E6: Intelligent Systems – Software Technology					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Software Development Process	1	VO	1.5		*1.5*

Elective module E6: Intelligent Systems – Software Technology					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Object-Oriented Analysis and Design	2	VU	3		*3*
Recommender Systems	2	VU	3		*3*
Mobile Computing, Laboratory	2	LU	3		*3*
Web Technology	3	VU	5	*5*	

Elective module E7: Intelligent Systems – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Intelligent Systems	4	SP	10	*10*	*10*
Construction of Mobile Robots	2	PT	5	*5*	
Seminar Intelligent Systems	3	SE	5		*5*
Seminar Software Technology	2	SE	3	*3*	
Software Technology Tools	2	SE	3		*3*
Seminar Computational Intelligence A	2	SE	3.5	*3.5*	
Seminar Computational Intelligence B	2	SE	3.5		*3.5*

DE: This course is offered in German only.
e: Recommended course, unless it was already completed in the bachelor's degree programme.

(6) Elective module catalogues Interactive and Visual Information Systems

Elective module F3: Interactive and Visual Information Systems – Mobile and Web Applications					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Mobile Applications	3	VU	5		*5*
Information Architecture and Web Usability	3	VU	5	*5*	
HCI: Applying User-Centred Design	3	VU	4.5		*4.5*
Information Visualisation	3	VU	5		*5*
User Interfaces	1.5	VU	2		*2*

Elective module F4: Interactive and Visual Information Systems – Data Mining and Artificial Intelligence					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Knowledge Discovery & Data Mining 1	2	VO	3		*3*
Knowledge Discovery & Data Mining 1	1	KU	1.5		*1.5*
Architecture of Machine Learning Systems	3	VU	5		*5*
Visual Analytics	3	VU	5		*5*
Social Media Technology	2	VU	3		*3*
Intelligent Systems	2	VO	3		*3*
Intelligent Systems	1	KU	2		*2*
3D Object Retrieval	3	VU	5		*5*
Intelligent User Interfaces	3	VU	5		*5*

Elective module F5: Interactive and Visual Information Systems – Computer Games					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Game Design and Development	3	VU	5	*5*	
Simulation and Animation	3	VU	5		*5*
Visualisation	3	VU	5	*5*	

Elective module F6: Interactive and Visual Information Systems – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Interactive and Visual Information Systems	4	SP	10	*10*	*10*
Seminar Interactive and Visual Information Systems	3	SE	5	*5*	*5*
Instructional Design in (Game-Based) Learning	2	SE	3		*3*
Applications of Innovative Technologies	2	SE	3	*3*	*3*

(7) Elective module catalogues Machine Learning

Elective module G3: Machine Learning – Learning Architectures					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Machine Learning 1[e]	2	VO	3		*3*
Machine Learning 1[e]	1	UE	1.5		*1.5*
Principles of Brain Computation	2	VO	3		*3*
Principles of Brain Computation	1	KU	2		*2*
Architecture of Machine Learning Systems	3	VU	5		*5*

Elective module G4: Machine Learning – Signal Processing					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Adaptive Systems	2	VO	3	*3*	
Adaptive Systems	1	UE	2	*2*	
Linguistic Foundations of Speech and Language Technology	2	VO	3	*3*	
Automatic Speech Recognition	2	VO	3		*3*
Signal Processing	2	VO	3		*3*
Signal Processing	1	UE	2		*2*
Spoken Language in Human and Human-Computer Dialogue	2	VU	3		*3*
Nonlinear Signal Processing	2	VO	3		*3*
Nonlinear Signal Processing	1	UE	2		*2*
Speech Synthesis	2	VU	3	*3*	
Advanced Information Theory	2	VU	3		*3*

Elective module G5: Machine Learning – Optimisation					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Numerical Optimisation[e]	3	VO	4.5	*4.5*	
Numerical Optimisation[e]	2	UE	2.5	*2.5*	
Convex Optimisation	3	VU	5		*5*

Elective module G6: Machine Learning – Statistics and Data Mining					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Statistics[DE]	3	VO	4	*4*	
Statistics[DE]	1	UE	2	*2*	
Recommender Systems	2	VU	3		*3*
Knowledge Discovery & Data Mining 1	2	VO	3		*3*
Knowledge Discovery & Data Mining 1	1	KU	1.5		*1.5*
Knowledge Discovery and Data Mining 2	3	VU	5	*5*	
Natural Language Processing	3	VU	5		*5*
Information Search and Retrieval	3	VU	5	*5*	
Network Science	3	VU	5	*5*	

Elective module G7: Machine Learning – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Machine Learning	4	SP	10	*10*	*10*
Seminar Computational Intelligence A	2	SE	3.5	*3.5*	
Seminar Computational Intelligence B	2	SE	3.5		*3.5*
Signal Processing and Machine Learning 1	2	SE	3.5	*3.5*	
Signal Processing and Machine Learning 2	2	SE	3.5		*3.5*

[DE]: This course is offered in German only.
[e]: Recommended course, unless it was already completed in the bachelor's degree programme.

(8) Elective module catalogues Robotics

Elective module H3: Robotics – Foundations of Robotics					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Context-Aware Computing	2	VO	3	*3*	
Context-Aware Computing	1	UE	1.5	*1.5*	
Kinematics and Robotics	2	VO	3		*3*
Kinematics and Robotics	1	KU	2		*2*
Navigation Systems	2	VU	3	*3*	
Inertial Navigation	2	VO	3		*3*
Inertial Navigation	1	KU	1.5		*1.5*
Industrial Robotics[DE]	2	VO	3	*3*	
Robotics Lab[DE]	3	LU	3	*3*	

Elective module H4: Robotics – Data Mining and Machine Learning

Course	SSt	Course Type	ECTS	Semester allocation WS	SS
Machine Learning 1	2	VO	3		*3*
Machine Learning 1	1	UE	1.5		*1.5*
Deep Learning	2	VO	3	*3*	
Deep Learning	1	KU	2	*2*	
Autonomously Learning Systems	2	VO	3	*3*	
Autonomously Learning Systems	1	KU	2	*2*	
Knowledge Discovery & Data Mining 1	2	VO	3		*3*
Knowledge Discovery & Data Mining 1	1	KU	1.5		*1.5*
Natural Language Processing	3	VU	5		*5*
Numerical Optimisation	3	VO	4.5	*4.5*	
Numerical Optimisation	2	UE	2.5	*2.5*	
Convex Optimisation	3	VU	5		*5*
Automatic Speech Recognition	2	VO	3		*3*
Intelligent User Interfaces	3	VU	5		*5*

Elective module H5: Robotics – Artificial Intelligence

Course	SSt	Course Type	ECTS	Semester allocation WS	SS
Basics in Artificial Intelligence and Logic[e,DE]	2	VU	3		*3*
Advanced Topics in Artificial Intelligence	2	VO	3	*3*	
Advanced Topics in Artificial Intelligence	1	UE	2	*2*	

Elective module H6: Robotics – Computer Vision

Course	SSt	Course Type	ECTS	Semester allocation WS	SS
Camera Drones	3	VU	5	*5*	
Image Based Measurement	2	VO	3	*3*	
Image Based Measurement, Laboratory	1	LU	2	*2*	

Elective module H7: Robotics – Software Engineering

Course	SSt	Course Type	ECTS	Semester allocation WS	SS
Software Engineering for Autonomous Robots	2	VU	3	*3*	
Designing Interactive Systems	2	VU	3		*3*
Design Thinking and Rapid Prototyping	3	LU	3		*3*
Modelling Technical Systems	2	VO	3		*3*
Modelling Technical Systems	1	KU	2		*2*
Embedded Systems	2	VO	3		*3*
Embedded Systems, Laboratory	1	LU	2		*2*

Elective module H8: Robotics – Projects and Seminars

Course	SSt	Course Type	ECTS	Semester allocation WS	SS
Seminar/Project Robotics	4	SP	10	*10*	*10*
Construction of Mobile Robots	2	PT	5	*5*	
Seminar Robotics	2	SE	3	*3*	

[DE]: This course is offered in German only.

[e]: Recommended course, unless it was already completed in the bachelor's degree programme.

(9) Elective module catalogues Software Technology

Elective module I3: Software Technology – Artificial Intelligence and Theoretical Computer Science

Course	Course			Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Advanced Topics in Artificial Intelligence	2	VO	3	*3*	
Advanced Topics in Artificial Intelligence	1	UE	2	*2*	
Configuration Systems	2	VU	3	*3*	
Intelligent Systems	2	VO	3		*3*
Intelligent Systems	1	KU	2		*2*
Problem Analysis and Complexity Theory	3	VU	4.5		*4.5*
Recommender Systems	2	VU	3		*3*

Elective module I4: Software Technology – Modelling and Formal Methods

Course	Course			Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Model Checking	2	VO	3		*3*
Model Checking	1	UE	2		*2*
Formal Specification and Design of Software	3	VU	5	*5*	
Modelling Technical Systems	2	VO	3		*3*
Modelling Technical Systems	1	KU	2		*2*
Model-Based Testing	3	VU	5	*5*	

Elective module I5: Software Technology – Software Design and Architecture

Course	Course			Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Designing Interactive Systems	2	VU	3		*3*
Architecture of Database Systems	3	VU	5	*5*	
Architecture of Machine Learning Systems	3	VU	5		*5*
Web Technology	3	VU	5	*5*	

Elective module I6: Software Technology – Software Engineering

Course	Course			Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Mobile Applications	3	VU	5		*5*
Software Engineering for Autonomous Robots	2	VU	3	*3*	
Design Thinking and Rapid Prototyping	3	LU	3		*3*
Agile Software Development	3	VU	5		*5*
Object-Oriented Analysis and Design	2	VU	3		*3*
Software Maintenance	3	VU	4.5		*4.5*
Quality Assurance in Software Development[e,DE]	2	VU	2.5		*2.5*
Industrial Software Development and Quality Management	2	VO	3		*3*
Industrial Software Development and Quality Management	1	UE	2		*2*

Elective module I7: Software Technology – Safe and Secure Systems					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Secure Software Development	2	VO	3	*3*	
Secure Software Development	1	UE	2	*2*	
Secure Application Design	2	VO	3		*3*
Secure Application Design	1	KU	2		*2*
Software Testing for Safety-Critical Systems	2	VO	3	*3*	
Software Testing for Safety-Critical Systems	1	KU	2	*2*	
Advanced Topics in Software Testing	2	VO	3		*3*
Advanced Topics in Software Testing	1	KU	2		*2*

Elective module I8: Software Technology – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Software Technology	4	SP	10	*10*	*10*
Seminar Software Technology	2	SE	3	*3*	
Software Technology Tools	2	SE	3		*3*

DE: This course is offered in German only.
e: Recommended course, unless it was already completed in the bachelor's degree programme.

(10) Elective module catalogues Visual Computing

Elective module J3: Visual Computing – Foundations of Visual Computing					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Numerical Optimisation[e]	3	VO	4.5	*4.5*	
Numerical Optimisation[e]	2	UE	2.5	*2.5*	
Convex Optimisation	3	VU	5		*5*
Machine Learning 1[e]	2	VO	3		*3*
Machine Learning 1[e]	1	UE	1.5		*1.5*
Machine Learning 2	2	VO	3		*3*
Machine Learning 2	1	KU	2		*2*
Mathematical Principles in Visual Computing	3	VU	5		*5*

Elective module J4: Visual Computing – Computer Graphics					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
3D Computer Graphics and Realism	3	VU	5	*5*	
GPU Programming	3	VU	5		*5*
Discrete Differential Geometry	2	VO	3		*3*
Fundamentals of Geometry Processing[e]	3	VU	4.5		*4.5*

Elective module J5: Visual Computing – Computer Vision					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Camera Drones	3	VU	5	*5*	
Image and Video Understanding	2	VO	3	*3*	
Image and Video Understanding	1	KU	2	*2*	
Image Based Measurement	2	VO	3	*3*	
Image Based Measurement, Laboratory	1	LU	2	*2*	
Medical Image Analysis	2	VO	3		*3*
Medical Image Analysis	1	KU	2		*2*

Elective module J6: Visual Computing – Visualisation and Virtual Reality					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Virtual Reality	4	VU	7		*7*
Simulation and Animation	3	VU	5		*5*
Visualisation	3	VU	5	*5*	
Information Visualisation	3	VU	5		*5*
Augmented Reality	3	VU	5	*5*	
Computer Aided Geometric Design	3	VU	5	*5*	
3D Object Retrieval	3	VU	5		*5*

Elective module J7: Visual Computing – Projects and Seminars					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Seminar/Project Visual Computing	4	SP	10	*10*	*10*
Seminar Visual Computing	3	SE	5		*5*
Seminar Pattern Recognition	3	SE	5	*5*	

[e]: Recommended course, unless it was already completed in the bachelor's degree programme.

(11) Elective module catalogues Mathematical Foundations

Elective module K2: Mathematical Foundations – Linear Algebra and Numerics					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Linear Algebra 2[DE]	4	VO	6		*6*
Linear Algebra 2[DE]	2	UE	3		*3*
Technical Numerics 2	2	VO	3		*3*
Technical Numerics 2	1	UE	1		*1*

Elective module K3: Mathematical Foundations – Optimisation					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Convex Optimisation	3	VU	5		*5*
Numerical Optimisation[e]	3	VO	4.5	*4.5*	
Numerical Optimisation[e]	2	UE	2.5	*2.5*	
Discrete Differential Geometry[DE]	2	VO	3		*3*
Geometry for Computer Scientists	2	VU	3	*3*	

Elective module K4: Mathematical Foundations – Signal Processing and Control Systems					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Control Systems 1	2	VO	3		*3*
Control Systems 1	1	UE	1.5		*1.5*
Control Systems 2	2	VO	3	*3*	
Control Systems 2	1	UE	1.5	*1.5*	
Signal Processing	2	VO	3		*3*
Signal Processing	1	UE	2		*2*

Elective module K5: Mathematical Foundations – Complexity Theory					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Complexity Theory	3	VO	4.5	*4.5*	
Complexity Theory	1	UE	1	*1*	

Elective module K6: Mathematical Foundations – Statistics and Applications					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Applied Statistics	3	VO	4	*4*	
Applied Statistics	1	UE	2	*2*	
Computer Aided System Modelling and Simulation	2	VO	3	*3*	
Computer Aided System Modelling and Simulation	1	UE	2	*2*	
Mathematical Principles in Vision and Graphics	3	VU	5		*5*
Network Science	3	VU	5	*5*	
Seminar Cryptology and Privacy	2	SE	3.5	*3.5*	*3.5*
State Estimation and Filtering	2	VO	3	*3*	
State Estimation and Filtering	1	UE	2	*2*	

DE: This course is offered in German only.

(12) Elective module catalogues Statistics

Elective module L2: Statistics – Foundations					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Statistics[DE]	3	VO	4	*4*	
Statistics[DE]	1	UE	2	*2*	
Stochastic Simulation	2	VU	3		*3*
Statistics Seminar	2	SE	3.5		*3.5*

Elective module L3: Statistics – Statistical Analysis					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Regression Analysis	3	VO	4		*4*
Regression Analysis	1	UE	2		*2*
Generalised Linear Models	3	VO	4	*4*	

Elective module L3: Statistics – Statistical Analysis					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Generalised Linear Models	1	UE	2	*2*	
Time Series Analysis	3	VO	4		*4*
Time Series Analysis	1	UE	2		*2*

Elective module L4: Statistics – Models and Simulation					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Data Analysis and Introduction to R	2	VO	3	*3*	
Data Analysis and Introduction to R	1	UE	2	*2*	
Industrial Statistics	3	VO	4		*4*
Industrial Statistics	1	UE	2		*2*
Computational Statistics	3	VO	4		*4*
Computational Statistics	1	UE	2		*2*

DE: This course is offered in German only.

(13) Elective module catalogues Embedded and Mobile Systems

Elective module M2: Embedded and Mobile Systems – Embedded Systems					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Embedded Internet	2	VU	3	*3*	
Embedded Internet	2	LU	3	*3*	
Embedded Automotive Software	2	VU	3	*3*	
Real-Time Operating Systems	2	VO	3		*3*
Real-Time Operating Systems	1	LU	1.5		*1.5*
Sensor Networks	2	VU	3		*3*
Sensor Networks, Laboratory	2	LU	3		*3*
Processor Architecture	2	VO	3		*3*
Processor Architecture	1	LU	1.5		*1.5*

Elective module M3: Embedded and Mobile Systems – Embedded and Mobile Computing					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Context-Aware Computing	2	VO	3	*3*	
Context-Aware Computing	1	UE	1.5	*1.5*	
Fault-Tolerant Computing Systems	2	VO	3		*3*
Fault-Tolerant Computing Systems	1	UE	1.5		*1.5*
Power-Aware Computing	2	VU	3	*3*	
Power-Aware Computing, Laboratory	1	LU	1.5	*1.5*	
Mobile Computing, Seminar	3	SE	5		*5*

Elective module M4: Embedded and Mobile Systems – Software Development					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Industrial Software Development and Quality Management	2	VO	3		*3*
Industrial Software Development and Quality Management	1	UE	1.5		*1.5*
Fault-Tolerant Distributed Algorithms	2	VU	3	*3*	
Hardware-Software Codesign	2	VO	3		*3*
Hardware-Software Codesign	1	UE	1.5		*1.5*
Smart Service Development	2	VO	3		*3*
Smart Service Development	1	UE	1.5		*1.5*

(14) Elective module catalogue Science, Technology and Society

Elective module N: Science, Technology and Society					
Course		Course		Semester allocation	
	SSt	**Type**	**ECTS**	**WS**	**SS**
Science, Technology and Society: Core Concepts and Case Studies	2	VO	4	*4*	
Technology – Ethics – Politics[DE]	2	VU	4		*4*
Technology Assessment[DE]	2	SE	4	*4*	*4*
Gender & Technology 1[DE]	2	SE	4	*4*	
Futurology	2	VU	4	*4*	
Utopia and Dystopia of Technology	2	SE	4	*4*	
Self-Optimisation and Digitalisation of the Body	2	SE	4		*4*
History of Technology[DE]	2	VU	4		*4*
Special Topics in STS – Science, Technology and Society	2	SE	4	*4*	*4*

[DE]: This course is offered in German only.

Students may also take courses to deepen their knowledge of a foreign language (English or German) with a total scope of up to 3 ECTS credit points for a minor.

Courses with the title “Selected Topics of [module group name] (subtitle)” are assigned to the corresponding module groups, whereby one semester course hour usually corresponds to 1.5 ECTS credit points. These courses have descriptive subtitles and are offered with a total scope of 1-3 semester course hours for lectures (VO) and/or 1-2 semester course hours for exercises (UE) or 2-3 semester course hours for lectures with integrated exercises (VU). Courses with different subtitles must be classified as different courses.

§ 10 Free-choice courses

(1) The courses to be completed as part of the free-choice subject in the Master's Degree Programme Computer Science are designed to provide individual strategic focus and further development for the students. They may be freely selected

from the courses offered by any recognised national or international universities and also recognised national or international post-secondary educational institutions. Annex II includes a recommendation for free-choice courses.

(2) If no ECTS credit points are assigned to a free-choice course, each semester course hour (SSt) of this course is evaluated with one ECTS credit point. However, if such courses are lecture-type courses (VO), they are assigned 1.5 ECTS credit points for each semester course hour.

§ 11 Master's thesis

(1) The master's thesis serves as proof of the ability of the student to work on scientific topics independently and must also be acceptable in terms of content and methodology. The scope of the master's thesis must be determined in such a way that its completion can be reasonably and feasibly accomplished by the student within a period of six months.

(2) The subject of the master's thesis is to be assigned to the major. The officers responsible for study matters decides on exceptions.

(3) Prior to commencement of the master's thesis, the master's thesis must be registered via the responsible Dean's Office in conjunction with the officers responsible for study matters. The subject, the subject area to which the subject is assigned, and the supervisor along with the institute are to be recorded.

(4) 30 ECTS credit points are assigned to the master's thesis.

(5) The master's thesis must be submitted both in printed and also in electronic form for assessment.

§ 12 Registration requirements for courses/examinations

Admission to the master's degree examination before a committee requires proof of the positive assessment of all examination results according to § 8 to § 10 above and also proof of the positive assessment of the master's thesis.

§ 13 Stays abroad

(1) Recommended stays abroad

Students of the degree programme are recommended to study abroad for a semester. In this master's degree programme, the 2nd or 3rd semesters are particularly suitable for this purpose. Equivalent modules or courses completed during the stay abroad must be recognised by the officers responsible for study matters. For the recognition of examinations taken during stays abroad, please refer to § 78 (6) of the Universities Act (UG) (pre-notification of recognition).

Furthermore, upon application to the officers responsible for study matters, achievements from shorter study stays abroad, such as active participation in international summer or winter schools, may also be recognised with up to 3 ECTS credit points within the framework of free-choice courses.

IV Examination regulations and completion of studies

§ 14 Examination regulations

Courses are evaluated individually.

(1) Examinations for courses held as lectures (VO) cover the entire content of the course. Examinations may be oral only, written only or a combination of written and oral.

(2) For courses held as lectures with integrated exercises (VU), exercises (UE), laboratory courses (LU), design exercises (KU), field exercises (FU), projects (PT), seminars (SE), seminar projects (SP), and excursions (EX), the performance of a student is continually assessed on the basis of their contributions and/or through accompanying examinations. The assessment always consists of at least two examination components.

(3) If a module/module group includes several examination components, the overall module grade is to be determined by:

a. multiplying the grade of each examination result in connection with the module/module group with the ECTS credit points of the corresponding course,

b. adding the values calculated according to lit. a.,

c. dividing the result of the addition by the sum of the ECTS credit points of the courses, and

d. rounding the result of the division to a whole-numbered grade if required. The grade is rounded up if the decimal place exceeds 0.5. Otherwise, the grade is rounded down.

e. A positive module grade/module group grade may only be awarded if each individual examination performance has been assessed as positive.

f. In accordance with lit. a. to d., examinations in which the assessment only confirms the successful / unsuccessful participation must not be included in this calculation.

(4) Regulations on the repetition of partial performances in courses with continuous assessment are laid down in the part of the Statute of Graz University of Technology, Legal Regulations for Academic Affairs.

(5) The final master's examination before a committee consists of

- the presentation of the master's thesis (max. 25 minutes), and
- the defence of the master's thesis (examination interview).

(6) The total duration of the final master's examination before a committee is usually 60 minutes and must not exceed 75 minutes.

(7) The board of examiners consists of the master's thesis supervisor and two other members who are nominated by officers responsible for study matters after hearing the candidate. The chair must be held by a member of the board of examiners who is not the supervisor of the master's thesis.

(8) In accordance with § 24 (6) of the Excerpt of Statutes of Graz University of Technology, Legal Regulations for Academic Affairs, the grade of this final

examination before a committee is determined by the board of examiners on the basis of the performance delivered during the master's examination.

§ 15 Completion of studies

(1) With the positive assessment of the courses of all compulsory and elective modules, the free-choice courses, the master's thesis and the final master's examination before a committee, the master's degree programme is deemed to be completed.

(2) A degree certificate is issued upon successful completion of the degree programme. The master's degree certificate for the Master's Degree Programme Computer Science is composed of:

a. the major and the minor according to § 4 (including ECTS credit points) and their assessment,
b. the title and the assessment of the master's thesis,
c. the assessment of the final examination before a committee,
d. the ECTS credit points total for the free-choice courses according to § 10, and
e. the overall assessment according to § 11 of the part of the Statute of Graz University of Technology, Legal Regulations for Academic Affairs.

V Legal validity and transitional regulations

§ 16 Legal validity

This 2020 curriculum (TUGRAZonline abbreviation 20U) obtains legal validity on October 1, 2020.

§ 17 Transitional regulations

Students of the Master's Degree Programme Computer Science who are subject to the 2014 curriculum in its 2016 version when this curriculum enters into force on October 1, 2020, are entitled to complete their studies according to the provisions of the 2014 curriculum in its 2016 version by September 30, 2023. If the degree programme is not completed by September 30, 2023, students are subject to the curriculum for the Master's Degree Programme Computer Science as amended. Students are entitled to voluntarily opt for the new curriculum at any time within the admission periods. To this end, a written irrevocable declaration must be sent to the officers responsible for study matters.

Annex to the curriculum of the Master's Degree Programme Computer Science

Annex I.

Module descriptions and type of performance assessment

The examination of performance in modules is carried out by completing the intended ECTS credit points according to § 4.

Module group Algorithms and Theoretical Computer Science:

Compulsory module A1	**Algorithms and Theoretical Computer Science – Compulsory 1**
ECTS credit points:	9
Content:	This module covers the basics of higher probability theory and information theory and also algorithms and methods for counting up and down.
Learning outcomes:	Upon completion of the module, students will have developed an understanding of the basics of probability theory, information theory and methods and algorithms for counting up and down.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.
Prerequisites for participation:	Knowledge of probability calculation. Measure theory is an advantage. Basic mathematics (graph theory, combinatorics) and knowledge of algorithms. About the same level as the course in “Design and Analysis of Algorithms”.
Module offered:	every academic year

Compulsory module A2	**Algorithms and Theoretical Computer Science – Compulsory 2**
ECTS credit points:	13.5
Content:	This module covers structures of combinatorial, discrete and computational geometry and classical problems of combinatorial optimisation with emphasis on polynomially solvable problems. Furthermore, central techniques for dealing with NP-hard problems are presented.
Learning outcomes:	After the successful completion of this module, students will be familiar with the most important problems and algorithmic solution approaches of combinatorial optimisation and have in-depth knowledge of discrete geometric structures, methods for their analysis, and also efficient computer procedures for their processing.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE.
Prerequisites for participation:	Basic mathematical (Linear Algebra 1, Discrete Mathematics, Analysis 1) and algorithmic knowledge, e.g. asymptotic notations and simple algorithmic design principles.

Module offered:	every academic year

Elective module A3	**Algorithms and Theoretical Computer Science – Algorithms**
ECTS credit points:	max. 25
Content:	This module covers algorithms in various contexts such as graph theory, optimisation and game theory. Furthermore, it deals with methods for the analysis of combinatorial problems and complexity theory issues.
Learning outcomes:	Upon completion of the module, students will be able to expand and deepen their knowledge in the areas of “Algorithms and Data Structures”. They will be able to design and analyse algorithms independently and to solve problems of geometry, graph theory, combinatorics and optimisation algorithmically.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.
Prerequisites for participation:	Basic mathematical knowledge and also algorithmic knowledge of data structures and algorithms; basic programming skills.
Module offered:	every academic year

Elective module A4	**Algorithms and Theoretical Computer Science – Optimisation**
ECTS credit points:	max. 24.5
Content:	Optimisation algorithms are central to many areas of computer science. This module provides more in-depth knowledge in optimisation algorithms.
Learning outcomes:	Upon completion of this elective module, students will have a sound basic mathematical and algorithmic knowledge of optimisation methods.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Basic knowledge in analysis, linear algebra and algorithms.
Module offered:	every academic year

Elective module A5	**Algorithms and Theoretical Computer Science – Theoretical Computer Science**
ECTS credit points:	max. 23
Content:	This module provides in-depth knowledge of theoretical problems of computer science, especially in the fields of theoretical computer science, complexity theory, logic and information theory.
Learning outcomes:	Upon completion of this elective module, students will have sound mathematical knowledge of the theoretical foundations of computer science.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, KU, VU.
Prerequisites for participation:	Basic mathematical knowledge.

Module offered:	every academic year

Elective module A6	**Algorithms and Theoretical Computer Science – Applications**
ECTS credit points:	max. 35.5
Content:	This module covers issues in computer science with strong theoretical and/or algorithmic components and also number theory as a basis for many algorithmic issues.
Learning outcomes:	Upon completion of this elective module, students will have knowledge of various computer science subject areas with pronounced theoretical and/or algorithmic components.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, KU, VU
Prerequisites for participation:	Basic mathematical and algorithmic knowledge.
Module offered:	every academic year

Elective module A7	**Algorithms and Theoretical Computer Science – Projects and Seminars**
ECTS credit points:	10-15
Content:	Practical and/or theoretical implementation of a specific topic from a subfield of algorithm design and theoretical computer science. Independent review of the relevant literature and derivation of an assignment. Analysis and processing of the problem and drawing the necessary conclusions. Preparation of written contributions and oral presentations. This module also serves as preparation for the master's thesis.
Learning outcomes:	After successful completion of the course, students will have developed a deeper understanding of scientific working methods and will be able to carry out scientific work with simple assignments independently, and to produce a written paper on them. Students will be able to present scientific results orally and discuss them in a group.
Teaching and learning activities and methods:	Independent work under supervision, presentations, discussion in groups.
Prerequisites for participation:	In-depth knowledge of algorithms and/or knowledge in the field of theoretical computer science.
Module offered:	every academic year

Module group Data Science:

Compulsory module B1	**Data Science – Compulsory 1 (major and minor)**
ECTS credit points:	9.5
Content:	This module provides basic knowledge in data mining and analysis of large amounts of data. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation. Thus, this module covers

	the necessary basics for a further deepening of knowledge in the field of data science.
Learning outcomes:	After completing the subject, students will be familiar with the essential basics of data science and will also be able to implement these in practical applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, and VU.
Prerequisites for participation:	Basic knowledge of vector and matrix calculus, elementary differential calculus and probability theory and statistics.
Module offered:	every academic year

Compulsory module B2	**Data Science – Compulsory 2 (minor)**
ECTS credit points:	10
Content:	This module teaches the basic architecture of modern machine learning systems and the statistical analysis of large amounts of data in the R programming language. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation.
Learning outcomes:	Upon completion of the module, students will be familiar with the essential basics of modern machine learning systems and also statistical data analysis and they will be able to implement these in practical applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, and VU.
Prerequisites for participation:	Basic knowledge of vector and matrix calculus, elementary differential calculus and probability theory and statistics.
Module offered:	every academic year

Elective module B3	**Data Science – Data Mining and Machine Learning**
ECTS credit points:	max. 31.5
Content:	This module provides in-depth knowledge in data mining and optimisation, machine learning and neural networks. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation.
Learning outcomes:	Upon completion of the module, students will be familiar with the essential basics and applications of data mining and machine learning and will be able to implement these in practical applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, and VU.
Prerequisites for participation:	Basic knowledge of vector and matrix calculus, elementary differential calculus and probability theory and statistics.
Module offered:	every academic year

Elective module B4	**Data Science – Data Management**
ECTS credit points:	max. 13

Content:	This module provides in-depth knowledge in the fields of databases and data management of large data volumes. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation.
Learning outcomes:	Upon completion of the module, students will be familiar with the essential basics and applications of data management and will be able to implement these in practical applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, and VU.
Prerequisites for participation:	Basic knowledge of databases, programming and software development.
Module offered:	every academic year

Elective module B5	**Data Science – Social Data Science**
ECTS credit points:	max. 42
Content:	This module provides in-depth knowledge in the fields of recommender systems, social web, social media and user models and evaluation methodologies of such models. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation.
Learning outcomes:	Upon completion of the module, students will be familiar with essential basics and applications of social media and recommender systems and will be able to implement them in practical applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE and VU.
Prerequisites for participation:	Basic knowledge of vector and matrix calculus, elementary differential calculus and probability theory and statistics, programming and software development.
Module offered:	every academic year

Elective module B6	**Data Science – Statistics**
ECTS credit points:	max. 17
Content:	This module provides in-depth knowledge of statistics and its application in data science. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation.
Learning outcomes:	Upon completion of the module, students will be familiar with essential basics and applications of statistics in the field of data science and will be able to implement them in practical applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE and VU.
Prerequisites for participation:	Basic knowledge of vector and matrix calculus, elementary differential calculus and probability theory and statistics.
Module offered:	every academic year

Elective module B7	Data Science – Projects and Seminars
ECTS credit points:	10-15
Content:	Practice-oriented implementation of projects in the field of data science within the framework of interactive seminar events.
Learning outcomes:	Consolidation of knowledge in specific topics from the field of data science.
Teaching and learning activities and methods:	Preparation of the subjects within the framework of practice-oriented courses and seminars.
Prerequisites for participation:	Basic knowledge of vector and matrix calculus, elementary differential calculus and probability theory and statistics, programming and software development.
Module offered:	every academic year

Module group Games Engineering:

Compulsory module C1	Games Engineering – Compulsory 1
ECTS credit points:	10
Content:	Basics of game development, game design and real-time graphics.
Learning outcomes:	Upon completion of the compulsory module, students understand basic techniques and methods of game development and real-time graphics and have developed a first game prototype.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU
Prerequisites for participation:	Basic knowledge in the fields of software development and computer graphics.
Module offered:	every academic year

Compulsory module C2	Games Engineering – Compulsory 2
ECTS credit points:	10
Content:	In-depth knowledge of game development, game design, simulation and animation techniques.
Learning outcomes:	Upon completion of this compulsory module, students will have sound knowledge of techniques and methods of game development, and also simulation and animation techniques.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VU.
Prerequisites for participation:	Basic knowledge in the fields of software development and computer graphics.
Module offered:	every academic year

Elective module C3	Games Engineering – Algorithms and Software Technologies
ECTS credit points:	max. 22
Content:	Introduction to the basics of selected chapters relevant for game development such as artificial intelligence, algorithms, mobile applications, GPU programming or software technologies.
Learning outcomes:	Upon completion of this elective module, students will have sound knowledge of selected chapters of game development and basic areas of software development relevant to game development.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, VU
Prerequisites for participation:	Basic knowledge of software development and computer graphics, data structures and algorithms.
Module offered:	every academic year

Elective module C4	Games Engineering – Human Computer Interaction
ECTS credit points:	max. 25.5
Content:	Introduction to the basics of human computer interaction, such as the design and evaluation of user interactions or data analytics in game design.
Learning outcomes:	Upon completion of this elective module, students will have knowledge of the design and also the evaluation and analysis of human-machine interactions.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VU.
Prerequisites for participation:	Basic knowledge in the field of software development.
Module offered:	every academic year

Elective module C5	Games Engineering – Visual Computing and Virtual Experiences
ECTS credit points:	max. 27
Content:	Introduction to the basics of computer graphics and visual computing, virtual and augmented reality, and 3D modelling.
Learning outcomes:	Upon completion of this elective module, students will master relevant methods from the fields of visual computing and computer graphics, and also the implementation of augmented reality and virtual reality experiences.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, VU
Prerequisites for participation:	Basic knowledge in the fields of software development and computer graphics.
Module offered:	every academic year

Elective module C6	Games Engineering – Projects and Seminars
ECTS credit points:	10 - 14.5
Content:	Deepening the knowledge of concepts, techniques and applications in the field of games engineering.
Learning outcomes:	Consolidation of knowledge in various topics within the framework of practice-oriented courses and seminars.
Teaching and learning activities and methods:	Project and seminar papers.
Prerequisites for participation:	Basic knowledge in the fields of software development and computer graphics.
Module offered:	every academic year

Module group Information Security:

Compulsory module D1	Information Security – Compulsory 1
ECTS credit points:	10
Content:	This module teaches the basics in the fields of cryptography and the security of software systems. Using concrete practical examples, both cryptographic and programming security mechanisms are analysed and designed. Simultaneously, students are taught the principles and theoretical foundations of cryptography and secure programming.
Learning outcomes:	Upon completion of the module, students will be familiar with basic aspects of cryptography and the secure implementation of software and will be able to put them into practice.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE
Prerequisites for participation:	Basic knowledge in information security, e.g. the course in “Information Security”.
Module offered:	every academic year

Compulsory module D2	Information Security – Compulsory 2
ECTS credit points:	10
Content:	This module teaches the basics in the fields of designing secure systems/applications and checking the correctness of concrete implementations in practice. Introduction of concepts and methodologies based on selected application scenarios. In addition, safety analyses are conducted and basic design techniques are taught. Furthermore, the basics of test strategies and formal techniques for checking the correctness of software and hardware are presented. These will also be deepened based on practical examples.
Learning outcomes:	Upon completion of the module, students will be familiar with basic aspects of safe system design and techniques for verifying concrete implementations and will be able to put these into practice.

Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE.
Prerequisites for participation:	Basic knowledge in information security, e.g. the course in “Information Security”.
Module offered:	every academic year

Elective module D3	**Information Security – Cryptology & Privacy**
ECTS credit points:	max. 20.5
Content:	This module provides in-depth knowledge of basic and applied aspects of cryptography and also techniques for the protection of data and privacy. Topics include cryptanalysis methods to analyse the mathematical security of symmetric and asymmetric cryptographic algorithms, modern cryptographic protocols and technical approaches to privacy protection, basics of complexity theory, and coding theory. The contents covered range from classical basics to current research questions in the field of cryptography.
Learning outcomes:	Upon completion of the module, students will have a sound overview and in-depth theoretical and practical knowledge of the many possible applications and security features of modern cryptography and also of the technical and mathematical possibilities of data protection.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Completion of the course “Cryptography”.
Module offered:	every academic year

Elective module D4	**Information Security – System Security**
ECTS credit points:	max. 25
Content:	This module offers a comprehensive consolidation of the knowledge in system design and system security. Essential fields in this context are hardware architectures, operating systems, compilers, networks and in particular side-channel attacks that occur at the interfaces of the technologies. The contents are taught in a practice-oriented manner. Therefore, practical exercises for the design and safety analysis of systems are an essential part of the module.
Learning outcomes:	Upon completion of the module, students will have a deeper understanding of the structure and security of digital systems. This ranges from hardware to applications in the cloud.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Completion of the course “Secure Software Development”.
Module offered:	every academic year

Elective module D5	Information Security – Formal Methods
ECTS credit points:	max. 25
Content:	This module provides advanced testing and verification methods for hardware and software. It teaches the theoretical principles of logic, probability theory and stochastics, which are necessary for the precise specification of security-critical properties of systems and the modelling and analysis of systems and security risks. The module includes intelligent fully automated testing methods, which use system models to automate test activities, and model-based verification methods, which will be able to prove the accuracy of a system description with respect to a formal specification.
Learning outcomes:	Upon completion of the module, students will be able to model complex, security-critical systems and analyse them using state-of-the-art testing and verification methods in order to achieve maximum test coverage and guarantee critical system properties in a verifiable manner.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Completion of the course “Verification and Testing”.
Module offered:	every academic year

Elective module D6	Information Security – Secure Applications
ECTS credit points:	max 20.5
Content:	This module covers questions in the area of the concrete implementation of security-relevant applications in practice. In addition to the subject area of mobile security and the protection of products from their design to the end of the product life cycle, fundamental legal issues are also taught. Furthermore, the module also teaches the basics for the design of fault-tolerant systems and basics in the field of data analysis.
Learning outcomes:	Upon completion of the module, students will have a sound overview of technical and legal aspects of implementing security-critical applications in practice.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Completion of the course “Secure Application Design”.
Module offered:	every academic year

Elective module D7	Information Security – Projects and Seminars
ECTS credit points:	10-15
Content:	Practical and/or theoretical implementation of a specific topic from a subfield of information security. Independent review of the relevant literature and derivation of an assignment. Analysis and processing of the problem and drawing the necessary conclusions. Preparation of written contributions and oral presentations. This module also serves as preparation for the master's thesis.
Learning outcomes:	After successful completion of the course, students will have developed a deeper understanding of scientific working

	methods and will be able to carry out scientific work with simple assignments independently, and to produce a written paper on them. Students will be able to present scientific results orally and discuss them in a group.
Teaching and learning activities and methods:	Independent work under supervision, presentations, discussion in groups.
Prerequisites for participation:	none
Module offered:	every academic year

Module group Intelligent Systems:

Compulsory module E1	**Intelligent Systems – Compulsory 1**
ECTS credit points:	9.5
Content:	Transfer of knowledge on essential methods and techniques of artificial intelligence by means of practical examples from industrial challenges. Increasing knowledge of knowledge representation approaches and inference methods. Theoretical basics are consolidated accordingly through practical exercises and the implementation of concrete software systems.
Learning outcomes:	Upon completion of the module, students will be familiar with essential methods of artificial intelligence and its application in so-called AI-based systems. In this context they will also be able to identify the appropriate approach for specific problems and to implement solutions accordingly.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU.
Prerequisites for participation:	Basic knowledge of methods of artificial intelligence.
Module offered:	every academic year

Compulsory module E2	**Intelligent Systems – Compulsory 2**
ECTS credit points:	10
Content:	This module teaches essential methods and techniques from the fields of natural language processing and intelligent user interfaces. In this context, it is about the integration of AI methods in the design of user interfaces. Theoretical basics are consolidated accordingly through practical exercises and the implementation of concrete software systems.
Learning outcomes:	Upon completion of the module, students will be familiar with essential methods of natural language processing and intelligent user interfaces. In this context, they will also be able to identify the appropriate solution for specific problems and to design and implement user interfaces under consideration of essential usability criteria.
Teaching and learning activities and methods:	Combination of theoretical and practical courses: VU.
Prerequisites for participation:	Basic knowledge of methods of artificial intelligence.

Module offered:	every academic year

Elective module E3	**Intelligent Systems – Artificial Intelligence**
ECTS credit points:	max. 11
Content:	Teaching of basic and advanced methods and techniques of artificial intelligence. A central focus in this context is also on specific application areas, including knowledge-based configuration and robotics.
Learning outcomes:	Upon completion of this module, students will have a basic understanding of techniques and methods, especially in the field of “Symbolic AI” and how these can be linked to approaches from the area of “Subsymbolic AI”.
Teaching and learning activities and methods:	Combination of theoretical and practical courses: VU, VO, UE
Prerequisites for participation:	Basic knowledge in logic and artificial intelligence.
Module offered:	every academic year

Elective module E4	**Intelligent Systems – Data Mining and Machine Learning**
ECTS credit points:	max. 29.5
Content:	This module teaches basic and advanced methods and techniques of “Subsymbolic AI”. In addition to different machine learning approaches, students will be introduced to brain computation methods. Basic methods of data analysis with corresponding tool support are another module focus.
Learning outcomes:	Upon completion of this module, students will have a basic understanding of techniques and methods, especially in the field of “Subsymbolic AI”.
Teaching and learning activities and methods:	Combination of theoretical and practical courses: VU, VO, UE, KU.
Prerequisites for participation:	Basic knowledge in artificial intelligence.
Module offered:	every academic year

Elective module E5	**Intelligent Systems – Robotics**
ECTS credit points:	max. 17.5
Content:	This module teaches basic and advanced methods and techniques of the field of robotics, such as, amongst others, mobile robots, navigation systems, context-aware computing and further associated topics.
Learning outcomes:	Upon completion of this module, students will have a basic understanding of techniques and methods, especially in the field of Robotics.
Teaching and learning activities and methods:	Combination of theoretical and practical courses: VU, VO, LU, UE.
Prerequisites for participation:	Basic knowledge in artificial intelligence.
Module offered:	every academic year

Elective module E6	Intelligent Systems – Software Technology
ECTS credit points:	max. 15.5
Content:	This module teaches basic and advanced knowledge in the field of software technology with a strong focus on development processes (how to create software), analysis and design approaches, development of mobile and web-based systems and application in the field of adaptive systems, amongst others by using the example of recommender systems.
Learning outcomes:	Upon completion of the module, students will have a basic understanding of software processes and corresponding implementation technologies.
Teaching and learning activities and methods:	Combination of theoretical and practical courses: VU, VO, LU.
Prerequisites for participation:	Basic knowledge in the field of software technology.
Module offered:	every academic year

Elective module E7	Intelligent Systems – Projects and Seminars
ECTS credit points:	10 - 15
Content:	Practice-oriented implementation of intelligent systems and preparation of issues related to intelligent systems within the framework of interactive seminar events.
Learning outcomes:	Consolidation of knowledge in specific topics from the field of “Intelligent Systems”.
Teaching and learning activities and methods:	Preparation of the subjects within the framework of practice-oriented courses and seminars.
Prerequisites for participation:	Basic knowledge in the field of software technology.
Module offered:	every academic year

Module group Interactive and Visual Information Systems:

Compulsory module F1	Interactive and Visual Information Systems – Compulsory 1
ECTS credit points:	11.5
Content:	Information systems serve as interfaces between data and users to solve a wide variety of application tasks and problems. Information systems are used to store, index and search data, and also to analyse and explore data. They are a central component of any information infrastructure. The focus of this module is on approaches for the design, development and evaluation of user-related information systems, including visual-interactive technologies for the representation, navigation, search, exploration, analysis and presentation of data and documents.
Learning outcomes:	Understand, apply, develop and evaluate concepts for effective and efficient visual and interactive information systems.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, VU, SE, PT.

Prerequisites for participation:	Basic knowledge of databases, human-machine interaction, data structures and algorithms.
Module offered:	every academic year

Compulsory module F2	**Interactive and Visual Information Systems – Compulsory 2**
ECTS credit points:	8
Content:	Information systems serve as interfaces between data and users to solve a wide variety of application tasks and problems. Information systems are used to store, index and search data, and also to analyse and explore data. They are a central component of any information infrastructure. The compulsory courses of this module focus on web technologies and evaluation methodology.
Learning outcomes:	Understand, apply, develop and evaluate concepts for effective and efficient visual and interactive information systems.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VU.
Prerequisites for participation:	Basic knowledge of databases, human-machine interaction, data structures and algorithms.
Module offered:	every academic year

Elective module F3	**Interactive and Visual Information Systems – Mobile and Web Applications**
ECTS credit points:	max. 21.5
Content:	The further development of data networks and portable devices creates new applications for information systems in mobile and distributed environments. This elective module investigates, implements and evaluates concepts and techniques for the design and realisation of visual and interactive information systems for mobile and distributed environments.
Learning outcomes:	Design, implementation and evaluation of visual and interactive information systems for mobile and distributed/web-based applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO.
Prerequisites for participation:	Basic knowledge of databases, human-machine interaction, data structures and algorithms.
Module offered:	every academic year

Elective module F4	**Interactive and Visual Information Systems – Data Mining and Artificial Intelligence**
ECTS credit points:	max. 32.5
Content:	Automatic methods of data analysis are an important basis for the development of modern information systems. Examples are the personalisation of information services (recommending), the analysis of information for data exploration and

	classification, and decision support (e.g. cluster analysis, classification, relevance feedback, predictive analysis). This elective module teaches concepts and techniques for the automatic analysis and visualisation of data, such as architectures for efficient data search and analysis, recommender system technologies, visual and multimedia information retrieval, and also visual and interactive data analysis.
Learning outcomes:	Design, implementation and evaluation of intelligent information systems.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU.
Prerequisites for participation:	Basic knowledge of databases, human-machine interaction, data structures and algorithms.
Module offered:	every academic year

Elective module F5	**Interactive and Visual Information Systems – Computer Games**
ECTS credit points:	max. 15
Content:	Computer games have become a very important interactive medium, used not only for entertainment but also for learning, teaching and creativity. This elective module teaches concepts and techniques of computer games, such as design and development models, and also techniques of simulation and animation, and interactive data and knowledge visualisation.
Learning outcomes:	Design, implementation and evaluation of computer games in all application areas, including learning/teaching and serious gaming.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VU.
Prerequisites for participation:	Basic knowledge in the field of human-machine interaction, visual systems.
Module offered:	every academic year

Elective module F6	**Interactive and Visual Information Systems – Projects and Seminars**
ECTS credit points:	10 - 15
Content:	Deepening the knowledge of concepts, techniques and applications in the field of interactive and visual information systems.
Learning outcomes:	In-depth individual occupation with methods of the subject on the basis of seminar papers, including review and presentation of current research contributions. In the area of projects, the independent processing of a more comprehensive development or research task in the field of interactive and visual information systems.
Teaching and learning activities and methods:	Project and seminar papers

Prerequisites for participation:	Basic knowledge in the field of human-machine interaction, visual systems.
Module offered:	every academic year

Module group Machine Learning:

Compulsory module G1	**Machine Learning – Compulsory 1**
ECTS credit points:	10
Content:	This module examines mathematical basics and applications of machine learning and deep learning in particular.
Learning outcomes:	Upon successful completion of the module, students understand the mathematical basics of machine learning and deep learning and can apply them in practical examples.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of theoretical and practical examples.
Prerequisites for participation:	Basic knowledge in machine learning.
Module offered:	every academic year

Compulsory module G2	**Machine Learning – Compulsory 2**
ECTS credit points:	5
Content:	This module examines mathematical basics and applications of autonomous learning. Particular attention is given to the subject area of reinforcement learning.
Learning outcomes:	Upon successful completion of the module, students will understand the basics of autonomous learning and basic mathematical concepts in reinforcement learning. Students can apply this basic knowledge to simple problems.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of theoretical and practical examples.
Prerequisites for participation:	Basic knowledge in machine learning.
Module offered:	every academic year

Elective module G3	**Machine Learning – Learning Architectures**
ECTS credit points:	max. 14.5
Content:	This module provides basic knowledge of machine learning and also knowledge of the architecture of biological and artificial learning systems. From the biological point of view, the principles of calculating and learning in the brain are discussed. With regard to artificial systems, it covers the architectures of large machine learning systems.
Learning outcomes:	Upon successful completion of the module, students will understand the basics of machine learning and will have become familiar with various principles of biological and artificial learning architectures. They will be able to apply the principles and methods learned to simple practical problems.

Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of theoretical and practical examples.
Prerequisites for participation:	none
Module offered:	every academic year

Elective module G4	**Machine Learning – Signal Processing**
ECTS credit points:	max. 30
Content:	This module covers the basics for all levels of speech signal processing up to automatic speech recognition, speech synthesis and dialogue systems. Another focus is on adaptive and non-linear signal processing.
Learning outcomes:	Upon successful completion of the module, students will understand the basics of adaptive and non-linear signal processing, linguistics and human-machine communication using spoken language. The students will be able to apply the methods taught to practical problems.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	none
Module offered:	every academic year

Elective module G5	**Machine Learning – Optimisation**
ECTS credit points:	max. 12
Content:	Many machine learning methods use optimisation algorithms to optimise models. This module provides more in-depth basic knowledge in optimisation.
Learning outcomes:	Upon completion of this elective module, students will have a sound basic knowledge of mathematical optimisation methods.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	Basic knowledge in analysis, linear algebra and algorithms.
Module offered:	every academic year

Elective module G6	**Machine Learning – Statistics and Data Mining**
ECTS credit points:	max. 33.5
Content:	This module provides basic knowledge in data mining, statistics and the analysis of large amounts of data. This subject not only covers the theoretical basics in detail – great importance is also attached to practical implementation.
Learning outcomes:	After completing the subject, students will be familiar with the essential basics of data science and will also be able to implement these in practical applications.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	Basic knowledge in vector and matrix calculus, elementary differential calculus and probability theory and statistics.

Module offered:	every academic year

Elective module G7	**Machine Learning – Projects and Seminars**
ECTS credit points:	10-15
Content:	Practical and/or theoretical implementation of a specific topic from a subfield of machine learning. Independent review of the relevant literature and derivation of an assignment. Analysis and processing of the problem and drawing the necessary conclusions. Preparation of written contributions and oral presentations. This module also serves as preparation for the master's thesis.
Learning outcomes:	After successful completion of the course, students will have developed a deeper understanding of scientific working methods and will be able to carry out scientific work with simple assignments independently, and to produce a written paper on them. Students will be able to present scientific results orally and discuss them in a group.
Teaching and learning activities and methods:	Independent work under supervision, presentations, discussion in groups.
Prerequisites for participation:	none
Module offered:	every academic year

Module group Robotics:

Compulsory module H1	**Robotics – Compulsory 1**
ECTS credit points:	10
Content:	This module provides a comprehensive introduction to mobile robots with a focus on mathematical description of robot systems and methods to solve fundamental problems such as localisation, path planning and mapping.
Learning outcomes:	Upon completion of the module, students will have a basic understanding of mobile robots and will be able to describe mobile robot systems and solve fundamental tasks.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Basic knowledge in discrete mathematics, linear algebra and programming.
Module offered:	every academic year

Compulsory module H2	**Robotics – Compulsory 2**
ECTS credit points:	10
Content:	This module offers a comprehensive deepening of knowledge in the fields of perception and decision making in robot systems. It covers special topics from computer vision, knowledge representation and reasoning.

Learning outcomes:	Upon completion of the module, students will be able to develop modules for robot systems that “see” and “conclude”.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.
Prerequisites for participation:	Basic knowledge in computer vision and logic.
Module offered:	every academic year

Elective module H3	**Robotics – Foundations of Robotics**
ECTS credit points:	max. 23
Content:	This module offers a comprehensive deepening of knowledge in core areas of robotics such as kinematics, robot arms, and navigation.
Learning outcomes:	Upon completion of the module, students will have a sound knowledge of the core areas of robotics and can use this knowledge to design appropriate modules for robot systems.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Basic knowledge in discrete mathematics, linear algebra and programming.
Module offered:	every academic year

Elective module H4	**Robotics – Data Mining and Machine Learning**
ECTS credit points:	max. 44
Content:	The development of intelligent robot systems requires methods from the fields of knowledge acquisition, machine learning and mathematics. This module teaches the basics of the required methods.
Learning outcomes:	Upon completion of the module, students will have a sound overview of methods of acquiring knowledge and models, machine learning and optimisation and will be able to apply these methods to solve tasks in robotics.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU
Prerequisites for participation:	Basic knowledge in discrete mathematics, linear algebra and programming.
Module offered:	every academic year

Elective module H5	**Robotics – Artificial Intelligence**
ECTS credit points:	max. 8
Content:	This module provides a deepening of knowledge in the field of symbolic methods of artificial intelligence to represent and solve complex decision processes in robot systems.
Learning outcomes:	Upon completion, students will be able to select suitable representations for problems in decision making and to model these problems and solve them with suitable tools.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.

Prerequisites for participation:	Basic knowledge in discrete mathematics, logic and programming.
Module offered:	every academic year

Elective module H6	**Robotics – Computer Vision**
ECTS credit points:	max. 10
Content:	This module provides a deeper understanding of camera-based robot systems. This includes methods for stationary, ground-based and flying robot systems.
Learning outcomes:	Upon completion of the module, students will be able to solve perception problems in robot systems with the help of computer vision.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.
Prerequisites for participation:	Basic knowledge in computer vision and programming.
Module offered:	every academic year

Elective module H7	**Robotics – Software Engineering**
ECTS credit points:	max. 19
Content:	Consolidation of knowledge in the field of software engineering with a focus on robot systems. This includes software architectures, concepts and development methods for Cyber Physical Systems and Embedded Systems.
Learning outcomes:	Upon completion of this module, students will be able to design, implement, and validate a software system for a robot.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.
Prerequisites for participation:	Basic knowledge in software engineering and programming.
Module offered:	every academic year

Elective module H8	**Robotics – Projects and Seminars**
ECTS credit points:	10-15
Content:	Teaching of advanced contents in the field of robotics, which students are expected to carry out largely independently under supervision.
Learning outcomes:	After successful completion of the course, students will have developed a deeper understanding of scientific working methods and will be able to carry out scientific work with simple assignments independently, and to produce a written paper on them. Students will be able to present scientific results orally and discuss them in a group.
Teaching and learning activities and methods:	Independent work under supervision, presentations, discussion in groups.
Prerequisites for participation:	none

Module offered:	every academic year

Module group Software Technology:

Compulsory module I1	**Software Technology – Compulsory 1**
ECTS credit points:	10
Content:	Introduction to the basics of software technology with a focus on programming languages and their principles. This includes the basics of programming languages and compiler development.
Learning outcomes:	Upon completion of this module, students will be able to develop their own programming languages and respective compilers. In addition, students can analyse and evaluate different concepts of programming languages and their special features.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, VU
Prerequisites for participation:	Basic knowledge in data structures, programming and discrete mathematics.
Module offered:	every academic year

Compulsory module I2	**Software Technology – Compulsory 2**
ECTS credit points:	9.5
Content:	Introduction to the basics of verification and testing as well as the efficient creation of software with the help of Design Patterns.
Learning outcomes:	Upon completion of this module, students will be able to create programmes based on design patterns and ensure their correctness through formal verification and software testing.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE.
Prerequisites for participation:	Basic knowledge of data structures, programming and discrete mathematics.
Module offered:	every academic year

Elective module I3	**Software Technology – Artificial Intelligence and Theoretical Computer Science**
ECTS credit points:	max. 20.5
Content:	Introduction to the basics of Artificial Intelligence and its application such as Configuration, Recommender Systems, and Diagnosis.
Learning outcomes:	In this elective module, students are taught the basics of logic-based Artificial Intelligence. Graduates will also gain insight into the development of tools based on Artificial Intelligence to solve practical problems.

Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU, KU.
Prerequisites for participation:	Basics in logic and mathematics. Basics of algorithms, data structures and programming
Module offered:	every academic year

Elective module I4	**Software Technology – Modelling and Formal Methods**
ECTS credit points:	max. 20
Content:	Imparting the basic knowledge on formal methods for the creation of specifications and formal verification.
Learning outcomes:	Students who complete this elective module receive an in-depth introduction to the specification and modelling of systems with the aim of formal system verification.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, KU, VU.
Prerequisites for participation:	Basics in logic and mathematics. Basics of algorithms, data structures and programming
Module offered:	every academic year

Elective module I5	**Software Technology – Software Design and Architecture**
ECTS credit points:	max. 18
Content:	Introduction to the basics of system and software architectures based on practical examples such as databases and machine learning software.
Learning outcomes:	In this elective module, students are taught the basics of architectures by means of various applications.
Teaching and learning activities and methods:	A combination of practice-oriented courses: VU.
Prerequisites for participation:	Basics of algorithms, data structures and programming. Basics of machine learning and databases.
Module offered:	every academic year

Elective module I6	**Software Technology – Software Engineering**
ECTS credit points:	max. 31
Content:	Extension of knowledge in the field of software engineering for mobile applications and also fields of application, such as software maintenance. The module also provides in-depth knowledge in the areas of quality assurance and software development.
Learning outcomes:	In this elective module, students gain an in-depth insight into modern software development with a focus on quality assurance, processes, other fields of application such as software maintenance and the generation of mobile applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, KU, LU, VU.
Prerequisites for participation:	Basics of algorithms, data structures and programming.

Module offered:	every academic year

Elective module I7	**Software Technology – Safe and Secure Systems**
ECTS credit points:	max. 20
Content:	Introduction to the basics of creating safe and secure systems based on software. The development of secure software and also the review of software with regard to the requirements for safety critical systems are discussed.
Learning outcomes:	Students receive a solid foundation for the creation of Safe and Secure Software.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, KU.
Prerequisites for participation:	Basics in logic and mathematics. Basics of algorithms, data structures and programming.
Module offered:	every academic year

Elective module I8	**Software Technology – Projects and Seminars**
ECTS credit points:	10-15
Content:	Teaching of advanced contents in the field of robotics, which students are expected to carry out largely independently under supervision.
Learning outcomes:	After successful completion of the course, students will have developed a deeper understanding of scientific working methods and will be able to carry out scientific work with simple assignments independently, and to produce a written paper on them. Students will be able to present scientific results orally and discuss them in a group.
Teaching and learning activities and methods:	Independent work under supervision, presentations, discussion in groups.
Prerequisites for participation:	none
Module offered:	every academic year

Module group Visual Computing:

Compulsory module J1	**Visual Computing – Compulsory 1**
ECTS credit points:	10
Content:	Basic methods of image processing, pattern recognition and real-time graphics.
Learning outcomes:	Upon completion of this compulsory module, students will be proficient in basic techniques of image processing, pattern recognition and real-time graphics.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU.
Prerequisites for participation:	Basic knowledge in image processing, computer graphics and numerical optimisation.

Module offered:	every academic year

Compulsory module J2	**Visual Computing – Compulsory 2**
ECTS credit points:	10
Content:	Basic methods of machine vision and 3D modelling in computer graphics.
Learning outcomes:	Upon completion of this compulsory module, students have a profound basic knowledge of machine vision and the three-dimensional modelling of objects.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, KU, VU.
Prerequisites for participation:	none
Module offered:	every academic year

Elective module J3	**Visual Computing – Foundations of Visual Computing**
ECTS credit points:	max. 26.5
Content:	Advanced basic knowledge in mathematics, optimisation and machine learning.
Learning outcomes:	Upon completion of this elective module, students will have profound basic mathematical knowledge of the methods of visual computing.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, KU, VU.
Prerequisites for participation:	Basic knowledge in analysis and linear algebra.
Module offered:	every academic year

Elective module J4	**Visual Computing – Computer Graphics**
ECTS credit points:	max. 17.5
Content:	Further courses in computer graphics, geometry processing and GPU programming.
Learning outcomes:	Upon completion of this elective module, students possess knowledge of advanced methods from computer graphics and are proficient in the corresponding programming languages.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, VU.
Prerequisites for participation:	Compulsory module J1
Module offered:	every academic year

Elective module J5	**Visual Computing – Computer Vision**
ECTS credit points:	max. 20
Content:	Further courses in the fields of image and video understanding, machine vision and medical image processing.
Learning outcomes:	Upon completion of this elective module, students will be proficient in advanced methods for extracting and analysing

	information from images and videos and solving practical problems such as navigating with drones or answering medical questions.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, VU, KU, LU.
Prerequisites for participation:	Compulsory module J1
Module offered:	every academic year

Elective module J6	**Visual Computing – Visualisation and Virtual Reality**
ECTS credit points:	max. 37
Content:	Further courses in the fields of visualisation, animation, virtual and augmented reality and 3D modelling.
Learning outcomes:	Upon completion of this elective module, students will be proficient in the relevant methods of visualisation, virtual and augmented reality, animation and 3D modelling. In this elective module, great attention is paid to the close connection between theoretical content and practical implementation.
Teaching and learning activities and methods:	Lectures with integrated exercises: VU
Prerequisites for participation:	Compulsory module J1
Module offered:	every academic year

Elective module J7	**Visual Computing – Projects and Seminars**
ECTS credit points:	10-15
Content:	Project and seminars
Learning outcomes:	Upon completion of the seminars from this elective module, students have acquired specialist knowledge from current topics in Visual Computing. Upon completion of the project, students can use this expertise to solve practical problems independently.
Teaching and learning activities and methods:	Seminars and project: SE, PT
Prerequisites for participation:	Compulsory module J1
Module offered:	every academic year

Module group Supplementary Mathematical Foundations:

Compulsory module K1	**Supplementary Mathematical Foundations – Compulsory 1**
ECTS credit points:	7
Content:	Numerical approximation methods are essential for the simulation of technical processes. In this module the basics of numerical mathematics are introduced. The focus is on the algorithmic description and understanding of the algorithms.
Learning outcomes:	Upon successful completion of the course, students understand the basic principles of numerical mathematics for the approximate solution of various problems.

Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	Knowledge of differential and integral calculus in one dimension, and linear algebra.
Module offered:	every academic year

Elective module K2	**Supplementary Mathematical Foundations – Linear Algebra and Numerics**
ECTS credit points:	max. 13
Content:	This module deals with in-depth topics from the fields of linear algebra and technical numerics, with the latter focusing in paticular on the finite element method. In order to achieve this, general mathematical skills such as the comprehension and independent execution of proofs are trained.
Learning outcomes:	Upon successful completion of the module, students will have developed advanced mathematical skills such as the comprehension and construction of proofs, with a focus on linear algebra problems. They will have also developed an understanding of the mathematical principles of the finite element method and will be able to apply them to standard examples.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of sample calculations.
Prerequisites for participation:	Knowledge of differential and integral calculus in one dimension, and linear algebra.
Module offered:	every academic year

Elective module K3	**Supplementary Mathematical Foundations – Optimisation**
ECTS credit points:	max. 18
Content:	Advanced basic knowledge in mathematics, optimisation and discrete differential geometry.
Learning outcomes:	Upon completion of this elective module, students will have a sound basic mathematical knowledge of optimisation and discrete differential geometry.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	Basic knowledge in analysis and linear algebra.
Module offered:	every academic year

Elective module K4	**Supplementary Mathematical Foundations – Signal Processing and Control Systems**
ECTS credit points:	max. 14
Content:	Theory of discrete-time signals and systems and algorithms of signal processing, as well as fundamentals of system and control theory. Calculation of discrete-time system descriptions of given continuous-time systems.
Learning outcomes:	Upon completion of this module, students will have developed an understanding of basic properties of time-discrete signals

	and systems and their mathematical description. They will have the ability to design and apply digital signal processing systems. Students will be able to understand and systematically solve practically relevant problems of classical control engineering.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	Basic knowledge of mathematics, electrical engineering and linear algebra. Sound knowledge of the theory of linear time-invariant systems.
Module offered:	every academic year

Elective module K5	**Supplementary Mathematical Foundations – Complexity Theory**
ECTS credit points:	max. 5.5
Content:	In-depth questions of theoretical computer science, in particular complexity theory and approximation.
Learning outcomes:	Upon completion of the module, students have gained in-depth knowledge in the field of theoretical computer science.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	none
Module offered:	every academic year

Elective module K6	**Supplementary Mathematical Foundations – Statistics and Applications**
ECTS credit points:	max. 29.5
Content:	This module includes supplementary courses from the field of applied mathematics in computer science and applied statistics. The module is designed to deepen the understanding of mathematical concepts used in computer science.
Learning outcomes:	Upon completion of courses of this module, students will be able to define, structure and perform statistical problems. They will be able to apply mathematical principles in computer science related areas.
Teaching and learning activities and methods:	Multimedia-supported lecture. The contents are processed and discussed by means of examples.
Prerequisites for participation:	Basics of probability theory and statistics.
Module offered:	every academic year

Module group Supplementary Statistics:

Compulsory module L1	**Supplementary Statistics – Compulsory 1**
ECTS credit points:	6
Content:	This module covers methods that serve to model and analyse dependent variables. In addition to an introduction to the

	basics of multivariate statistics, the focus lies on methods for dimensional reduction, classification and experimental design. The practical implementation of the acquired contents is illustrated using specific examples.
Learning outcomes:	Upon completion of the module, students will be able to deal with important statistical problems using multivariate methods and methods of experimental design.
Teaching and learning activities and methods:	Convey an advanced understanding of processes (VO) and their practical implementation (UE).
Prerequisites for participation:	Basic knowledge of statistics and probability theory, stochastic processes, vector and matrix calculus.
Module offered:	every academic year

Elective module L2	**Supplementary Statistics – Foundations**
ECTS credit points:	max. 12.5
Content:	This module is an introduction to the basics of mathematical statistics. On this basis and as a practical supplement, stochastic simulation methods (especially: the Monte Carlo method) for the calculation of statistical and probabilistic parameters are discussed.
Learning outcomes:	Upon completion of the module, students will be able to accurately formulate and describe statistical problems mathematically and to reproduce them in simulations.
Teaching and learning activities and methods:	Theoretical understanding of basic statistical concepts. Courses: VO, UE.
Prerequisites for participation:	Basic knowledge of statistics and probability theory, stochastic processes, analysis.
Module offered:	every academic year. The course Stochastic Simulation is offered every second year.

Elective module L3	**Supplementary Statistics – Statistical Analysis**
ECTS credit points:	max. 18
Content:	This module provides insight into various stochastic structures that generate complex data material and which can be used to analyse and interpret the data.
Learning outcomes:	Upon completion of the module, students will be independently able to postulate suitable statistical models for available data and to use these to gain specific insights into their generating mechanisms.
Teaching and learning activities and methods:	Problem-oriented presentation of the content with case studies from statistical practice. Independent solving of exercises by the participants. Courses: VO, UE
Prerequisites for participation:	Basic knowledge of statistics and probability theory, stochastic processes, vector and matrix calculus.
Module offered:	every academic year

Elective module L4	Supplementary Statistics – Models and Simulation
ECTS credit points:	max. 17
Content:	This module provides theoretical knowledge as well as practical experience in the specific application of high-dimensional and computationally intensive statistical methods in different areas. Emphasis is placed on the application of various methods to real data problems.
Learning outcomes:	Upon completion of the module, students will be able to formulate and model different statistical problems. In particular, multivariate methods and methods of experimental design are treated.
Teaching and learning activities and methods:	Problem-oriented presentation of the content with case studies from statistical practice. Independent solving of exercises by the participants. Courses: VO, UE.
Prerequisites for participation:	Basic knowledge of statistics and probability theory, stochastic processes, vector and matrix calculus.
Module offered:	every academic year. The courses “Industrial Statistics” and “Computational Statistics” are offered every second academic year.

Module group Supplementary Embedded and Mobile Systems:

Compulsory module M1:	Embedded and Mobile Systems – Compulsory 1
ECTS credit points:	4.5
Content:	The courses “Embedded Systems” provide basic knowledge about the architecture of embedded systems, their hardware and software (e.g. microcontrollers and basic software) as well as the associated software development and design models.
Learning outcomes:	Upon completion of the courses, students will have an in-depth insight into the basic concepts of embedded systems. They will be able to analyse tasks and to apply the acquired methods to solve simple problems.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, LU
Prerequisites for participation:	none
Module offered:	every academic year

Elective module M2	Embedded and Mobile Systems – Embedded Systems
ECTS credit points:	max. 24
Content:	The courses in this elective module provide and deepen theoretical and practical knowledge about design, implementation and analysis of embedded systems. Hardware and hardware-related software are covered as well as their integration into vehicles, cyber physical systems, sensors, actuators or computer systems in the Internet of Things.
Learning outcomes:	Upon completion of the module, students will be able to design, implement and analyse complex, hardware-oriented software of embedded systems.

Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, LU, VU.
Prerequisites for participation:	none
Module offered:	every academic year

Elective module M3	**Embedded and Mobile Systems – Embedded and Mobile Computing**
ECTS credit points:	max. 18.5
Content:	The courses in this elective module provide and deepen theoretical and practical knowledge about design, implementation and analysis of mobile, embedded systems. Focus lies on the associated hardware and software as well as their context, location, performance and error-related properties.
Learning outcomes:	Upon completion of the module, students will be able to design the hardware and software of embedded and mobile systems in a fault-tolerant manner and with context, location and performance-based methods.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU and seminar/project paper.
Prerequisites for participation:	none
Module offered:	every academic year

Module S	**Embedded and Mobile Systems – Software Development**
ECTS credit points:	max. 16.5
Content:	The courses in this catalogue provide and deepen theoretical and practical knowledge about design, implementation and analysis of embedded systems. Hardware and software development and the corresponding co-design are treated as well as the application in an industrial context.
Learning outcomes:	Upon completion of the module, students will be able to design the hardware and software of embedded systems and evaluate them with regard to industrial applications.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, UE, VU.
Prerequisites for participation:	none
Module offered:	every academic year

Elective module Science, Technology and Society:

Module N	**Science, Technology and Society**
ECTS credit points:	max. 4
Content:	The courses in this catalogue provide a deeper understanding of the fundamental importance of science and technology for contemporary societies and their role in responsibly addressing societal challenges.

Learning outcomes:	Upon completion of the module, students will be able to understand and reflect on the interrelationships between science, technology and society. They will be familiar with the relevant literature and will be able to relate it to the subject-specific problems of their studies.
Teaching and learning activities and methods:	A combination of theoretical and practical courses: VO, VU, SE
Prerequisites for participation:	none
Module offered:	every academic year

Annex II.

Recommended free-choice courses

Free-choice courses may be freely chosen from the courses offered by recognised national or international universities and recognised national or international post-secondary educational institutions, according to § 10 of this curriculum.

In order to broaden the basic knowledge students acquire in the subject areas of this degree programme, courses in foreign languages, social competence, technology assessment as well as women's and gender studies are recommended. In particular, we would like to refer students to the courses offered by the Graz University of Technology service department Languages, Key Competencies and In-House Training or treffpunkt sprachen and Centre for Social Competence of the University of Graz as well as the Science, Technology and Society Unit.

Annex III.

Equivalence list

Courses for which the equivalence or recognition is defined in this part of the Annex to the curriculum do not require separate recognition by the officers responsible for study matters. Reference is made to the possibility of individual recognition according to § 78 of the Universities Act (UG) by decisions from the officers responsible for study matters.

An equivalence list defines the equal value of successfully completed courses of this curriculum and the previous curriculum. This equivalence applies in both directions, that is, successfully completed courses of the previous curriculum may be credited in this curriculum and successfully completed courses of this curriculum may be credited in the previous curriculum.

Courses of Graz University of Technology that are the same with regard to name and type, the number of ECTS credit points and the number of semester course hours are considered to be equivalent, and are thus not explicitly listed in the equivalence list.

Present Curriculum 2020				Previous curriculum for 2014, Version 2016			
Course	**Course type**	**SSt**	**ECTS**	**Course**	**Course type**	**SSt**	**ECTS**
Intelligent Systems	VO	2	3	Expert Systems	VO	2	3
Intelligent Systems	KU	1	2	Expert Systems	KU	1	2
Machine Learning 2	VO	2	3	Machine Learning	VO	2	3
Machine Learning 2	KU	1	2	Machine Learning	KU	1	2
Deep Learning	VO	2	3	Neural Networks	VO	2	3
Deep Learning	KU	1	2	Neural Networks	KU	1	2
Knowledge Discovery & Data Mining 1	VO	2	3	Knowledge Discovery & Data Mining 1	VO	2	2.5
Image and Video Understanding	VO	2	3	Image Understanding	VO	2	3
Image and Video Understanding	KU	1	2	Image Understanding	KU	1	2
GPU Programming 0.5 ECTS for free-choice subject	VU	3	5	Real-Time Graphics 2	VO	1	1.5
				Real-Time Graphics 2	KU	2	4
Mathematical Principles in Visual Computing	VU	3	5	Mathematical Principles in Vision and Graphics	VU	3	5
Cryptography	VO	2	3	Applied Cryptography	VO	2	3
Cryptography	KU	1	2	Applied Cryptography	KU	1	2
Cryptanalysis	VO	2	3	Applied Cryptography 2	VO	2	3
Cryptanalysis	KU	1	2	Applied Cryptography 2	KU	1	2
Privacy Enhancing Technologies	VO	2	3	IT Security	VO	2	3
Privacy Enhancing Technologies	KU	1	2	IT Security	KU	1	2
Seminar Cryptology and Privacy	SE	2	3.5	Selected Topics IT Security 2	SE	2	3.5
Secure Software Development	VO	2	3	Security Aspects in Software Development	VO	2	3
Secure Software Development	KU	1	2	Security Aspects in Software Development	KU	1	2
Digital System Integration and Programming	VU	3	5	System-on-Chip Architectures and Modelling	VU	3	5
Side-Channel Security	VU	3	5	Embedded Security	VU	3	5
Mobile Security	VO	2	3	Advanced Computer Networks	VO	2	3
Mobile Security	KU	1	2	Advanced Computer Networks	KU	1	2
Complexity Theory	VO	3	4.5	Theoretical Computer Science II	VO	3	4
Complexity Theory	UE	1	1	Theoretical Computer Science II	UE	1	1
Inertial Navigation	VO	2	3	Integrated Navigation	VO	2	3

Present Curriculum 2020				Previous curriculum for 2014, Version 2016			
Course	**Course type**	**SSt**	**ECTS**	**Course**	**Course type**	**SSt**	**ECTS**
Inertial Navigation	KU	1	1.5	Integrated Navigation	UE	1	1.5
Numerical Optimisation	VO	3	4.5	Optimisation for Computer Science	VO	2	3
Numerical Optimisation	UE	2	2.5	Optimisation for Computer Science	UE	1	2
Computational Social Systems 1	VU	3	5	Web Science and Web Technology	VU	2	3
Computational Social Systems 2	VU	3	5	Science 2.0	VU	2	3
Architecture of Database Systems	VU	3	5	Structured Data Management – Advanced Topics	VU	3	5
Automatic Speech Recognition	VO	2	3	Speech Communication 2	VO	2	3
Spoken Language in Human and Human-Computer Dialogue	VU	2	3	Speech Communication Laboratory	LU	2	4
Computer Aided Geometric Design	VU	3	5	Computer-Aided Geometric Design	VU	3	5
Context-Aware Computing	VO	2	3	Location-Aware Computing	VU	2	3
Context-Aware Computing 0.5 ECTS for free-choice subject	UE	1	1.5	Location-Aware Computing, Laboratory	LU	1	2
Processor Architecture	VO	2	3	Signal Processors	VO	2	3
Processor Architecture	LU	1	1.5	Signal Processors	LU	1	2

If, in the case of recognition for a VU that is based on a VO/UE or VO/KU combination, only part of the course was completed in the previous curriculum, the ECTS credit point part of the completed course will be recognised for the module of the course in the present curriculum.

In general, all courses of a catalogue of electives of the previous curriculum can be recognised in a module group of the present curriculum according to the table below.

Module group in the present curriculum for 2020	Catalogue of electives of the previous curriculum for 2014, Version 2016
A: Algorithms and Theoretical Computer Science	Algorithms
E: Intelligent Systems *or* G: Machine Learning	Computational Intelligence
J: Visual Computing	Computer Graphics
J: Visual Computing	Computer Vision
D: Information Security	IT Security
B: Data Science	Knowledge Technologies
F: Interactive and Visual Information Systems	Multimedia Information Systems

Module group in the present curriculum for 2020	Catalogue of electives of the previous curriculum for 2014, Version 2016
M: Supplementary Embedded and Mobile Systems	Pervasive Computing
H: Robotics	Robotics
I: Software Technology	Software Technology
K: Supplementary Mathematical Foundations	Mathematical Foundations

Annex IV.

Types of courses

Pursuant to § 4 (1) of the Excerpt of Statutes of Graz University of Technology, Legal Regulations for Academic Affairs, the following types of courses are offered at Graz University of Technology. The courses specified in number 2) to number 12) are courses with continuous assessment.

1) VO … Lecture: In lecture-type courses, students are given a didactically well-structured introduction to the sub-areas of the subject and its methods. In lectures, the content and methods of a subject are presented.
2) UE … Exercise : In exercises, students develop the ability to apply their subject knowledge to solve specific problems.
3) KU … Design exercise: In design exercises, abilities and skills are taught as part of a scientific pre-vocational education and training to deepen and/or broaden the subject matter of the respective lectures by means of design work. Special equipment or a specially equipped room is required.
4) LU … Laboratory course: Laboratory courses (LU) deepen and/or broaden the subject matter of the respective lectures by means of practical, experimental or design work. Students are taught abilities and skills as part of a scientific pre-vocational education and training with particularly intensive tutoring. An essential component of the laboratory courses is the drawing up of short logs on the work carried out.
5) PT … Project: In projects, experimental, theoretical and/or design applied work is carried out, or small research papers are written, taking into account all necessary steps. Projects must be completed with a written paper that is part of the assessment. Projects may be carried out as teamwork or individual work; in the case of teamwork, it must still be possible to assess individual performance within the team.
6) VU … Lecture with integrated exercises: In addition to the introduction in sub-areas of the subject and its methods, lectures with integrated exercises (VU) also offer guidance on independent acquisition of knowledge or independent application using examples.

7) SE … Seminar: Seminars introduce students to scientific methods, to the development and critical assessment of their own work results, to special topics in scientific literature and provide them with exercises in technical discussions. In seminars, students write, present and discuss papers.
8) SP … Seminar project: In seminar projects, students apply scientific methods to work on experimental, theoretical and/or design applied problems; or they carry out short research assignments, taking into account all the necessary steps. Seminar projects are completed with a written paper and an oral presentation that are part of the assessment. Seminar projects may be carried out as teamwork or individual work; in the case of teamwork, it must still be possible to assess individual performance within the team.
9) EX … Excursion: Due to their practical relevance outside the place of study, excursions help to illustrate the content developed in other types of courses.
10) OL … Orientation course: Orientation courses serve as a source of information and are intended to provide an overview of the degree programme.
11) PV ... Exclusive tutorial for doctoral programmes: This exclusive tutorial for doctoral programmes is a research seminar in the framework of a doctoral programme.
12) FU … Field exercise: Field exercises are held outside the premises of Graz University of Technology in the field (e.g. road area, construction sites, alpine terrain, forest, tunnels) and in some cases even in inhospitable weather conditions. The students complete the exercises mostly themselves, after having undergone appropriate preparation.