

DeCAIR: Developing Curricula for Artificial Intelligence and Robotics

Report on Surveying International B.Sc. Programs in AI and Robotics

Activity Information

Work Package	WP1 – Surveys and Needs Identification
Task	1.3 Survey and evaluation of AI and Robotics courses in similar bachelor programs
Activity Coordinator	TTU (Murad Alaqtash)
Participating Partners	TTU, UJ, BAU, UGR, UNIGE, UST, UNIPI
Objective(s)	<ul style="list-style-type: none">• Surveying international B.Sc. programs that are specialized in AIR or have significant AIR component to identify their main attributes in terms of curriculum, syllabi, resources, faculty members' expertise and collaboration with industry.
Due Date	March 7 th

Instructions

1. Activity coordinator is to coordinate with the focal point of UJ and BAU to collect information of **eight** international AIR **B.Sc. programs**. EU partners may provide suggestions regarding the programs to survey.
2. Activity coordinator is to coordinate with EU partners to provide information about their AIR B.Sc. Programs.
3. Information to be collected for each program is the main attributes reported in Table 1.3.1, and files for the Curriculum and Syllabi.
4. Activity coordinator is responsible for gathering the collected files and store them to the *Surveyed_BSC_Programs* shared folder. The files for each program should be stored in a separate folder with the following syntax *ProgramName_UniversityName*.
5. This report is to be prepared through collaboration of different partners and submitted to the WP lead by the activity coordinator. Filled tables should be added to this report.

Summary and Recommendations

Different international AIR related B.Sc. programs were explored. TTU and JU from Jordan and BAU from Lebanon surveyed 8 B.Sc. programs. In addition to three programs at our partner UST from Germany. Eventually, 11 bachelor programs from USA, Europe, and Asia were selected for this survey and listed below.

1. Computer science with artificial intelligence/ University of Nottingham, Malaysia
2. Intelligent Sys Engineering/ Indiana University Bloomington, USA
3. Artificial Intelligence/ Carnegie Mellon University, USA
4. Computer Science & Engineering: Artificial Intelligence, Robotics Track Option / University of Minnesota, USA
5. Computer Science, Intelligent Systems track / Columbia University, USA
6. Robotics and Intelligent Systems/ Jacobs University, Germany
7. Machine Intelligence and Robotics, 3 years / University for Information Science and Technology, Macedonia
8. Machine Intelligence and Robotics, 4 years/ University for Information Science and Technology, Macedonia
9. Mechatronics/ University of Stuttgart, Germany
10. Engineering Cybernetics / University of Stuttgart, Germany
11. Simulation Technology / University of Stuttgart, Germany

According to the comprehensive and intensive search, it is clearly noticed that the majority of undergraduate programs are either in computer science or electrical and computer engineering programs with minors or concentrations offer a set of courses in AIR.

In general, the following courses are common between all programs:

- Introduction to Artificial Intelligence
- Principles of Machine Learning
- Introduction to Natural Language processing
- Image processing and Computer Vision
- Introduction to Intelligent Robotic Systems/Autonomous Robotics

In addition, the following advanced topics were commonly listed as a compulsory or an elective for many programs:

- Artificial Intelligence II
- Machine Learning II
- Intelligent Systems/ Embedded Systems
- Introduction to Data Mining
- Neural Networks / Deep Learning

In general, these courses requires prerequisites on mathematics and programming that provide students with the fundamentals and the necessary background. These courses were covered in the relative engineering programs such as computer and electrical engineering.

In Jordan, particularly, the ministry of education and accreditation authority specify list of compulsory topics and courses related to different fields/ tracks, areas of specialty for engineering programs. In general, there are nearly 30 credit hours, i.e. 10 courses, out of the total 160 Cr.Hrs, can be designated for AIR.

The University of Stuttgart mainly offers three Bachelor of Science programs in AI and robotics. Their main features are summarized in the following table and further information is provided regarding the courses in AI and robotics. Note that the official teaching language for all three programs is German, although some courses are offered in English. In general, the emphasis in the first (especially four) semesters is on building a strong theoretical background for the students. To this end, and to provide a broad basic knowledge, the focus there is on mathematics, programming, and modeling. These points are also covered by the courses at the Institute of Engineering and Computational Mechanics and furthermore show our research work. After the first semesters, a wide range of specialization subjects is offered. Many of these are in robotics and AI. The strong theoretical background of the students is complemented by various practical trainings, especially in the Mechatronics and Engineering Cybernetics program. Those practical trainings are often integrated in the lecture course and carried out in the institute's own laboratories.

For general robotic studies, the Mechatronics B.Sc. program at the University of Stuttgart is recommended, as it covers a wide range of robotics problems based on fundamental knowledge in mathematics, programming and modeling. In addition, various practical trainings complete the theoretical courses.

If special attention is paid to general system dynamics and control engineering problems, the Engineering Cybernetics program is recommended. There is much overlap between this program and the Mechatronics program, especially in the area of robotics. Based on a strong mathematical background, some courses are attended together with mathematicians and physicists, students may continue to choose courses in AI.

The third recommended program is Simulation Technology. This program is research-oriented and involves almost all faculties of the University of Stuttgart. Therefore, students can choose almost any course, with many of them covering robotics and AI.

Note that subsequently, all possible elective courses are considered in terms of credit hours, although of course a student cannot choose all of them within their program.

Surveyed Programs

Table 1.3.1 Attributes of Surveyed B.Sc. Programs

Number	1	
Program Name	<i>Computer science with artificial intelligence BSc (Hons)</i>	
University	University of Nottingham Malaysia	
Country	UK, China, Malaysia	
URL	https://www.nottingham.edu.my/Study/Undergraduate-courses/Computer-Science/Computer-Science-with-Artificial-IntelligenceBSc-Hons.aspx	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	1+3 years	
AI Credit Hours	21	
Data Science Credit Hours	-	
Robotics Credit Hours	3	
AI Courses in Curriculum	1. Fundamentals of Artificial Intelligence (obligatory) 2. Artificial Intelligence Methods (obligatory) 3. Language and Computation (obligatory) 4. Computer Vision (obligatory) 5. Designing Intelligent Agents (obligatory) 6. Artificial Intelligence Methods (obligatory) 7. Language and Computation (obligatory)	
Robotics Courses in Curriculum	1. Autonomous Robotic Systems (obligatory)	

Number	1
Program Name	<i>Computer science with artificial intelligence BSc (Hons)</i>
Fundamental Courses to Support AIR	<ol style="list-style-type: none"> 1. Computer Fundamentals (obligatory) 2. Databases and Interfaces (obligatory) 3. Mathematics for Computer Scientists (obligatory) 4. Programming and Algorithms (obligatory) 5. Programming Paradigms (obligatory) 6. Software Engineering (obligatory) 7. Systems and Architecture (obligatory) 8. Algorithms Correctness and Efficiency (obligatory) 9. Operating Systems and Concurrency (obligatory) 10. Software Engineering Group Project (obligatory) 11. Software Maintenance (obligatory) 12. Software Specification (elective) 13. C++ Programming (elective)
Teaching and Research AIR Labs	
Research Groups	<ol style="list-style-type: none"> 1. <u>Computer Vision</u>, 2. <u>Evolutionary Computation</u>, 3. <u>Hypermedia</u>, 4. <u>Intelligent Reasoning Agents</u>, 5. <u>Machine Learning</u>, 6. <u>Neural Computation and</u> 7. <u>Operational Research</u>.
Collaboration with Industry <i>(List of sample projects)</i>	<ol style="list-style-type: none"> 1. 2.
Summary and Notes	
<p>Computer science with artificial intelligence is a computer science program with more specialist skills and knowledge in artificial intelligence (AI). In addition to fundamental computer science modules, the course covers topics including computer vision, expert systems, heuristic optimisation, the history and philosophy of artificial intelligence, intelligent agents, machine learning, neural networks and other intelligent systems.</p> <p>The Foundation in Science (2 or 3 semesters full-time) is 1+3 year programme that results in direct progression to the undergraduate programs. This rigorous programme provides students with a strong academic background that will result in enhanced language, mathematics, critical thinking and study skills.</p>	

Number	2	
Program Name	<i>Intelligent Sys Engineering BS</i>	
University	INDIANA UNIVERSITY BLOOMINGTON	
Country	USA	
URL	https://engineering.indiana.edu/programs/bs-intelligent-systems-engineering/index.html	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	120 (4 Years)	
AI Credit Hours	12	
Data Science Credit Hours	6	
Robotics Credit Hours	3	
AI Courses in Curriculum	https://igps.iu.edu/sisaadm-prd/maps/view/d8d4dc49-d8b2-4e19-8575-5e66b75003cb https://bulletins.iu.edu/iub/sice/2020-2021/undergraduate/courses/engineering.shtml https://bulletins.iu.edu/iub/sice/2020-2021/undergraduate/courses/computer-science.shtml 1. Intelligent Systems I 2. Intelligent Systems II 3. High Performance Computing (Elective) 4. Engineering Cloud Computing (Elective) 5. Data Representation (Elective) 6. Big Data Analytics (Elective) 7. Big Data Applications (Elective) 8. Scientific Visualization (Elective) 9. Introduction to Artificial Intelligence (Elective) 10. Game Development (Elective) 11. Principles of Machine Learning (Elective) 12. Introduction to Computer Vision (Elective) 13. Interactive Graphics (Elective)	
Robotics Courses in Curriculum	1. Embedded Systems (Elective) 2. Autonomous Robotics (Elective)	

Number	2
Program Name	<i>Intelligent Sys Engineering BS</i>
Fundamental Courses to Support AIR	<ol style="list-style-type: none"> 1. Engineering Innovation & Design 2. Engineering Computer Architectures 3. Software Systems Engineering 4. Computer Systems Engineering 5. Engineering Cyber-Physical Systems 6. Systems, Signals & Control 7. Statistics 8. Advanced Undergraduate Engineering Mathematical Methods 9. Digital Design With FPGAS 10. Introduction To Modeling And Simulation 11. Engineering Networks 12. Engineering Operating Systems 13. Engineering Distributed Systems (Elective) 14. Image Processing (Elective)
Teaching and Research AIR Labs	
Research Groups	
Collaboration with Industry <i>(List of sample projects)</i>	
Summary and Notes	
<p>After completing the 120 hrs program, students can choose a concentration program with additional 30 hrs. the concentrations are: Bioengineering Computer Engineering/Cyber-Physical Systems, and Nanoscale Systems Engineering.</p> <p>Students may obtain a minor degree by successfully completing five courses totaling a minimum of 15 hrs. minors are Human-Centered Computing , Human-Computer Interaction/Design, , Virtual Reality, Animal-Computer Interaction, Computer Science, and Intelligence Studies.</p> <p>https://bulletins.iu.edu/iub/sice/2020-2021/undergraduate/degree-programs/certificates-minors.shtml</p>	

Number	3	
Program Name	<i>Bsc in Artificial Intelligence</i>	
University	Carnegie Mellon University	
Country	USA	
URL	https://www.cs.cmu.edu/bs-in-artificial-intelligence/curriculum	
Program Nature	<input type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input checked="" type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input checked="" type="checkbox"/> Specialized program in Robotics
Total Credit Hours	120	
AI Credit Hours	4 core + 2 elective courses	
Data Science Credit Hours	Elective courses can be offered in the data science field.	
Robotics Credit Hours	2 elective courses	
AI Courses in Curriculum	<ol style="list-style-type: none"> 1. Concepts in Artificial Intelligence 2. Introduction to AI: Representation and Problem Solving 3. Introduction to Machine Learning 4. Take one of the following courses: <ol style="list-style-type: none"> a. Introduction to Natural Language Processing b. Introduction to Computer Vision 	
Robotics Courses in Curriculum		

Number	3
Program Name	<i>Bsc in Artificial Intelligence</i>
Fundamental Courses to Support AIR	<ul style="list-style-type: none"> • Decision Making and Robotics Cluster <ul style="list-style-type: none"> ○ Neural Computation (15-386) http://www.cnbc.cmu.edu/~tai/nc17.html ○ Autonomous Agents (15-482) http://www.cs.cmu.edu/~15482-f19/index.html ○ Truth, Justice and Algorithms (15-483) ○ Cognitive Robotics (15-494) https://www.cs.cmu.edu/afs/cs/academic/class/15494-s19/index.html ○ Strategic Reasoning for AI (new) ○ Planning Techniques for Robotics (16-350) http://www.cs.cmu.edu/~maxim/classes/robotplanning/ ○ Mobile Robot Programming Laboratory (16-362) http://www.cs.cmu.edu/~alonzo/teaching/16x62/16x62.html ○ Robot Kinematics and Dynamics (16-384) • Machine Learning Cluster <ul style="list-style-type: none"> ○ Deep Reinforcement Learning and Control (10-403) http://www.andrew.cmu.edu/course/10-403/ ○ Intermediate Deep Learning (10-417) https://andrejristeski.github.io/10417-20/ ○ Machine Learning for Structured Data (10-418) http://www.cs.cmu.edu/~mgormley/courses/10418/about.html ○ Machine Learning for Text Mining (11-441) http://www.cs.cmu.edu/~yiming/MLTM-f20-index.htm ○ Introduction to Deep Learning (11-485) https://deeplearning.cs.cmu.edu/S21/index.html ○ Advanced Data Analysis (36-402) https://www.stat.cmu.edu/~cshalizi/uADA/15/ • Perception and Language Cluster <ul style="list-style-type: none"> ○ Search Engines (11-442) ○ Speech Processing (11-492) ○ Computational Perception (15-387) ○ Computational Photography (15-463) ○ Vision Sensors (16-421) • Human-AI Interaction Cluster <ul style="list-style-type: none"> ○ Design of Artificial Intelligence Products (05-317) https://hcii.cmu.edu/courses/design-ai-products-and-services ○ Human-AI Interaction (05-318) http://www.humanaiclass.org/ ○ Designing Human-Centered Systems (05-391) ○ Human-Robot Interaction (16-467)
Teaching and Research AIR Labs	

Number	3
Program Name	<i>Bsc in Artificial Intelligence</i>
Research Groups	https://www.ml.cmu.edu/research/ https://www.ri.cmu.edu/
Collaboration with Industry <i>(List of sample projects)</i>	3. 4.
Summary and Notes	
<p>This program is specialized in AI and have many courses in AI and Robotics and data science This program is supported by other departments like Computer Science Department, Human-Computer Interaction Institute, Institute for Software Research, Language Technologies Institute, Machine Learning Department and Robotics Institute.</p>	

Number	4	
Program Name	<i>B.S. in Computer Science & Engineering: Artificial Intelligence/Robotics Track Option</i>	
University	University of Minnesota	
Country	USA	
URL	https://cse.umn.edu/cs/ba-bs https://cse.umn.edu/cs/track-electives#AI	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input checked="" type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	120	
AI Credit Hours	At least 4 courses to fulfill the requirements for the track and the students can select from clusters of courses in all these domains	
Data Science Credit Hours		
Robotics Credit Hours		
AI Courses in Curriculum	<ul style="list-style-type: none"> • CSCI 4511W - Introduction to Artificial Intelligence (4 cr) https://www-users.cs.umn.edu/~gini/4511/ • CSCI 5512 - Artificial Intelligence II (3 cr) http://vision.psych.umn.edu/users/schrater/schrater_lab/courses/AI2/ • CSCI 5561 - Computer Vision (3 cr) https://www-users.cs.umn.edu/~hspark/csci5561_F2020/csci5561.html • CSCI 5521 - Introduction to Machine Learning (3 cr) https://www-users.cselabs.umn.edu/classes/Fall-2020/csci5521-001/index.php?page=syllabus • CSCI 5523 - Introduction to Data Mining (3 cr) https://canvas.umn.edu/courses/98222 • CSCI 5525 - Machine Learning (3 cr) https://zstevenwu.com/courses/f19/csci5525/ 	
Robotics Courses in Curriculum	<ul style="list-style-type: none"> • CSCI 5551 - Introduction to Intelligent Robotic Systems (3 cr) http://mars.cs.umn.edu/classes/csci5551/ • CSCI 5552 - Sensing and Estimation in Robotics (3 cr) http://mars.cs.umn.edu/classes/csci5552/ • CSCI 5715 - From GPS and Virtual Globes to Spatial Computing (3 cr) http://classinfo.umn.edu/?shekhar+CSCI5715+Fall2016 	
Fundamental Courses to Support AIR		
Teaching and Research AIR Labs		

Number	4
Program Name	<i>B.S. in Computer Science & Engineering: Artificial Intelligence/Robotics Track Option</i>
Research Groups	<ul style="list-style-type: none"> • Artificial Intelligence, Robotics, and Vision Lab • Interactive Robotics and Vision Laboratory • Visual Information Processing Lab • Computational Perception and Action Lab • Applied Motion Lab https://cse.umn.edu/cs/robotics-AI?field_category_target_id=7046
Collaboration with Industry <i>(List of sample projects)</i>	5. 6.
Summary and Notes	
<p>Choose at least 4 if your goal is to “complete” a track.</p> <p>Core course (choose at least 2)</p> <p>CSCI 4511W - Introduction to Artificial Intelligence (4 cr)</p> <p>CSCI 5512 - Artificial Intelligence II (3 cr)</p> <p>CSCI 5551 - Introduction to Intelligent Robotic Systems (3 cr)</p> <p>CSCI 5561 - Computer Vision (3 cr)</p> <p>Other track courses</p> <p>CSCI 4707 - Practice of Database Systems (3 cr)</p> <p>CSCI 5521 - Introduction to Machine Learning (3 cr)</p> <p>CSCI 5523 - Introduction to Data Mining (3 cr)</p> <p>CSCI 5525 - Machine Learning (3 cr)</p> <p>CSCI 5552 - Sensing and Estimation in Robotics (3 cr)</p> <p>CSCI 5715 - From GPS and Virtual Globes to Spatial Computing (3 cr)</p> <p>LING 5801 - Computational Linguistics (4 cr)</p> <p>PSY 5018H - Math Models Human Behavior (3 cr)</p> <p>PSY 5036W - Computational Vision (3 cr)</p>	

Number	5	
Program Name	<i>Bsc in Computer Science, Intelligent Systems track</i>	
University	Columbia University	
Country	USA	
URL	https://www.cs.columbia.edu/education/undergraduate/ https://mice.cs.columbia.edu/c/d.php?d=253	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input checked="" type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	7 courses (21 units)	
AI Credit Hours	5	
Data Science Credit Hours	1	
Robotics Credit Hours	1	
AI Courses in Curriculum	<ul style="list-style-type: none"> • COMS W4701 Artificial Intelligence http://www.cs.columbia.edu/~kathy/cs4701/ • COMS W4705 Natural Language Processing http://www.cs.columbia.edu/~mcollins/cs4705-spring2019/ • COMS W4706 Spoken Language Processing http://catalog.barnard.edu/search/?P=COMS%20W4706 • COMS W4731 Computer Vision http://w4731.cs.columbia.edu/ • COMS W4771 Machine Learning http://www.cs.columbia.edu/~verma/classes/ml/index.html 	
Robotics Courses in Curriculum	<ul style="list-style-type: none"> • COMS W4733 Computational Aspects of Robotics https://www.cs.columbia.edu/~allen/F19/ 	
Fundamental Courses to Support AIR		
Teaching and Research AIR Labs	<ul style="list-style-type: none"> • Robotics Laboratory http://www.cs.columbia.edu/robotics/ 	
Research Groups		
Collaboration with Industry <i>(List of sample projects)</i>		
Summary and Notes		

Number	6	
Program Name	<i>BSc in Artificial Intelligence</i>	
University	University of Groningen	
Country	Netherland	
URL	https://www.rug.nl/bachelors/artificial-intelligence/?lang=en#!programme	
Program Nature	<input type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input checked="" type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	180 European Credit Transfer and Accumulation System (ECTS) An academic year consists of 60 European Credits (ECs). Most courses are worth 5 EC. One EC is the equivalent of 28 hours of study (preparing for/attending classes, practical, exams, groupwork etc.). Bachelor Project (10 EC, Year 3, Elective) Minor Electives (15 EC, Year 3, Obligatory)	
AI Credit Hours	50 ECs (can be further extended through 15 EC of elective courses and 10 EC of Bachelor Project) Maximum Total: 75 EC	
Data Science Credit Hours	10 ECs (can be further extended through 15 EC of elective courses and 10 EC of Bachelor Project) Maximum Total: 35 EC	
Robotics Credit Hours	5 ECs (can be further extended through 15 EC of elective courses and 10 EC of Bachelor Project) Maximum Total: 30 EC	
AI Courses in Curriculum	5. Artificial Intelligence I (Year 1, Obligatory) 6. Introduction to Artificial Intelligence (Year 1, Obligatory) 7. Introduction to Logic (Year 1, Obligatory) 8. Introduction to the Brain (Year 1, Obligatory) 9. Advanced Logic (Year 2, Obligatory) 10. Architectures of Intelligence (Year 2, Obligatory) 11. Knowledge and Agent Technology (Year 2, Obligatory) 12. Language and Speech Technology (Year 2, Obligatory) 13. Neural Networks (Year 2, Obligatory) 14. Practicals in e.g. Language and Speech Technology... (Year 2, Obligatory) 15. Artificial Intelligence II (Year 3, Obligatory)	
Robotics Courses in Curriculum	1. Autonomous Systems (Year 1, Obligatory) 2. Practicals in e.g. Autonomous Systems, Knowledge Technology... (Year 2, Obligatory)	

Number	6
Program Name	<i>BSc in Artificial Intelligence</i>
Fundamental Courses to Support AIR	<ol style="list-style-type: none"> 1. Algorithms and Data Structures in C (Year 1, Obligatory) 2. Basic Scientific Skills (Year 1, Obligatory) 3. Calculus (Year 1, Obligatory) 4. Cognitive Psychology, Logic (Year 1, Obligatory) 5. General Linguistics (Year 1, Obligatory) 6. Imperative Programming (Year 1, Obligatory) 7. Linear Algebra and Multivariable Calculus (Year 1, Obligatory) 8. Object-Oriented Programming (Year 2, Obligatory) 9. Philosophy of Cognitive Science (Year 2, Obligatory) 10. Signals and Systems (Year 2, Obligatory) 11. Statistics (Year 2, Obligatory)
Teaching and Research AIR Labs	NA
Research Groups	<ol style="list-style-type: none"> 8. Autonomous Perceptive Systems 9. Cognitive Modeling 10. Multi-Agent Systems 11. Robotics
Collaboration with Industry <i>(List of sample projects)</i>	NA - Only externally funded research projects by governmental programs and research foundations.
Summary and Notes	

Number	7	
Program Name	<i>BSc in Robotics and Intelligent Systems</i>	
University	Jacobs University	
Country	Germany	
URL	https://www.jacobs-university.de/study/undergraduate/programs/robotics-and-intelligent-systems	
Program Nature	<input type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input checked="" type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input checked="" type="checkbox"/> Specialized program in Robotics
Total Credit Hours	<p>180 European Credit Transfer and Accumulation System (ECTS) An academic year consists of 60 European Credits (ECs). Most courses are worth 5 EC. One EC is the equivalent of 28 hours of study (preparing for/attending classes, practical, exams, groupwork etc.).</p> <p>First Year: Students select introductory modules with a total of 45 EC from the CHOICE area of a variety of study programs, of which 22.5 EC will be from their intended major.</p> <p>Second Year: Students take modules with a total of 45 EC from in-depth, discipline-specific CORE modules.</p> <p>Third Year: RIS students take 15 EC of major-specific and major-related Specialization modules to consolidate their knowledge at the current state of research in areas of their choice.</p> <p>Jacobs Track: An important feature of Jacobs University’s educational concept, runs parallel to the disciplinary modules across all study years and is an integral part of the study program. Students are required to take 20 EC in the Methods area.</p>	
AI Credit Hours	20 EC (can be further extended by 7.5 EC through CHOICE and Specialization modules) Maximum Total: 27.5 EC	
Data Science Credit Hours	0 ECs (can be further extended by 5 EC through Methods modules) Maximum Total: 5 EC	
Robotics Credit Hours	35 ECs (can be further extended by 17.5 EC through CHOICE and Specialization modules) Maximum Total: 52.5 EC	

Number	7
Program Name	<i>BSc in Robotics and Intelligent Systems</i>
AI Courses in Curriculum	<p>16. CHOICE Module: Introduction to Robotics and Intelligent Systems (Year 1, 7.5 EC, Common for AI, and Robotics)</p> <p>17. CORE Module: RIS Project (Year 2, 5 EC, Common for AI, and Robotics)</p> <p>18. CORE Module: RIS Lab (Year 2, 5 EC, Common for AI and Robotics)</p> <p>19. CORE Module: Machine Learning (Year 2, 5 EC)</p> <p>20. CORE Module: Artificial Intelligence (Year 2, 5 EC)</p>
Robotics Courses in Curriculum	<p>1. CHOICE Module: Introduction to Robotics and Intelligent Systems (Year 1, 7.5 EC, Common for AI, and Robotics)</p> <p>2. CORE Module: RIS Project (Year 2, 5 EC, Common for AI, and Robotics)</p> <p>3. CORE Module: RIS Lab (Year 2, 5 EC, Common for AI, and Robotics)</p> <p>4. CORE Module: Robotics (Year 2, 5 EC)</p> <p>5. CORE Module: Automation (Year 2, 5 EC)</p> <p>6. CORE Module: Embedded Systems (Year 2, 5 EC)</p> <p>7. CORE Module: Control Systems (Year 2, 5 EC)</p> <p>8. CORE Module: Computer Vision (Year 2, 5CP)</p> <p>9. Specialization: Human Computer Interaction (Year 3, 5 EC)</p> <p>10. Specialization: Marine Robotics (Year 3, 5 EC)</p>

Number	7
Program Name	<i>BSc in Robotics and Intelligent Systems</i>
Fundamental Courses to Support AIR	12. CHOICE Module: Programming in C and C++ (Year 1, 7.5 EC) 13. CHOICE Module: Algorithms and Data Structures (Year 1, 7.5 EC) 14. CORE Module: Software Engineering (Year 3, 7.5 EC) 15. CORE Module: Databases and Web Services (Year 3, 7.5 EC) 16. CORE Module Operations Research (Year 3, 5 EC) 17. CORE Module: PCB design and measurement automation (Year 3, 5 EC) 18. CORE Module: Information Theory (Year 3, 5 EC) 19. Specialization from MATH: Stochastic Processes (Year 3, 5 EC) 20. Specialization from MATH: Stochastic Methods Lab (Year 3, 7.5 EC) 21. Specialization: Optimization (Year 3, 5 EC) 22. Specialization: Distributed Algorithms (Year 3, 5 EC) 23. Specialization: Computer Graphics (Year 3, 5 EC) 24. Specialization: Web Application Development (Year 3, 5 EC) 25. Specialization: Digital Design (Year 3, 5 EC) 26. Methods: Calculus and Linear Algebra I (5 EC) 27. Methods: Calculus and Linear Algebra II (5 EC) 28. Methods: Probability and Random Processes (5 EC)
Teaching and Research AIR Labs	NA
Research Groups	NA
Collaboration with Industry <i>(List of sample projects)</i>	NA – Only externally funded research projects by governmental programs and research foundations.
Summary and Notes	

Number	8-1	
Program Name	<i>Machine Intelligence and Robotics (MIR) 3 years (Another 4 years program is also offered)</i>	
University	University for Information Science and Technology	
Country	Macedonia	
URL	http://uist.edu.mk/academics/bachelors/aitmir/	
Program Nature	<input type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input checked="" type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input checked="" type="checkbox"/> Specialized program in Robotics
Total Credit Hours	180 European Credit Transfer and Accumulation System (ECTS) An academic year consists of 60 European Credits (EC). Most courses are worth 6 ECT. One EC is the equivalent of 28 hours of study (preparing for/attending classes, practical, exams, groupwork etc.).	
AI Credit Hours	12 ECTs (can be further extended through 30 ECT of elective courses) Maximum Total: 42 ECT	
Data Science Credit Hours	0 ECTs (can be further extended through 6 ECT) Maximum Total: 6 ECT	
Robotics Credit Hours	6 ECT	
AI Courses in Curriculum	21. Artificial Intelligence (Year 3, Obligatory) 22. Natural Language Processing (Elective) 23. Data Mining (Elective) 24. Pattern Recognition (Elective) 25. Data, Information, and Knowledge Engineering (Elective) 26. Computer Vision (Elective)	
Robotics Courses in Curriculum	3. Basics of robotics (Year 2, Obligatory) 4. Sensors and Actuators (Year 2, Obligatory)	

Number	8-1
Program Name	<i>Machine Intelligence and Robotics (MIR) 3 years (Another 4 years program is also offered)</i>
Fundamental Courses to Support AIR	29. Introduction to Programming (Year 1, Obligatory) 30. Mathematics 1 (Year 1, Obligatory) 31. Physics (Year 1, Obligatory) 32. Discrete Mathematics (Year 1, Obligatory) 33. Object Oriented Programming (Year 1, Obligatory) 34. Mathematics 2 (Year 1, Obligatory) 35. Script Programming (Year 1, Obligatory) 36. Introduction to electric circuits (Year 1, Obligatory) 37. Mathematics 3 (Year 2, Obligatory) 38. Digital Logic Circuits (Year 2, Obligatory) 39. Signals and systems (Year 2, Obligatory) 40. Microprocessors (Year 2, Obligatory) 41. Control Theory 1 (Year 3, Obligatory) 42. Probability and Statistics (Year 3, Obligatory) 43. Programmable Logical Controllers (Year 3, Obligatory) 44. A large pool of 75 Major Elective courses (See PDF files, each of 6 ECT)
Teaching and Research AIR Labs	NA
Research Groups	NA – Two centers are available in the institution: 1. The Center for Intellectual Property and Technology Transfer (supported with a grant under The European Commission’s Seventh Framework Programme) 2. The Center for BioEngineering
Collaboration with Industry <i>(List of sample projects)</i>	NA
Summary and Notes	

Number	8-2	
Program Name	<i>Machine Intelligence and Robotics (MIR) 4 years (Another 3 years program is also offered)</i>	
University	University for Information Science and Technology	
Country	Macedonia	
URL	http://uist.edu.mk/academics/bachelors/aitmir/	
Program Nature	<input type="checkbox"/> General program with AI component <input type="checkbox"/> General program with Data Science component <input type="checkbox"/> General program with Robotics component	<input checked="" type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input checked="" type="checkbox"/> Specialized program in Robotics
Total Credit Hours	240 European Credit Transfer and Accumulation System (ECTS) An academic year consists of 60 European Credits (ECs). Most courses are worth 6 ECTS. One EC is the equivalent of 28 hours of study (preparing for/attending classes, practical, exams, groupwork etc.).	
AI Credit Hours	12 ECTS (can be further extended through 30 ECs of elective courses and 6 ECTS of Diploma Work)	
Data Science Credit Hours	0 ECTS (can be further extended through 6 ECTS of elective courses and 6 ECTS of Diploma Work)	
Robotics Credit Hours	18 ECTS (can be further extended through 6 ECTS of Diploma Work)	
AI Courses in Curriculum	27. Artificial Intelligence (Year 3, Obligatory) 28. Machine Learning (Year 4, Obligatory) 29. Natural Language Processing (Elective) 30. Data Mining (Elective) 31. Pattern Recognition (Elective) 32. Data, Information, and Knowledge Engineering (Elective) 33. Computer Vision (Elective)	
Robotics Courses in Curriculum	5. Basics of robotics (Year 2, Obligatory) 6. Sensors and Actuators (Year 2, Obligatory) 7. Automotive Control Systems (Year 4, Obligatory)	

Number	8-2
Program Name	<i>Machine Intelligence and Robotics (MIR) 4 years (Another 3 years program is also offered)</i>
Fundamental Courses to Support AIR	45. Introduction to Programming (Year 1, Obligatory) 46. Mathematics 1 (Year 1, Obligatory) 47. Physics (Year 1, Obligatory) 48. Discrete Mathematics (Year 1, Obligatory) 49. Object Oriented Programming (Year 1, Obligatory) 50. Mathematics 2 (Year 1, Obligatory) 51. Script Programming (Year 1, Obligatory) 52. Introduction to electric circuits (Year 1, Obligatory) 53. Mathematics 3 (Year 2, Obligatory) 54. Digital Logic Circuits (Year 2, Obligatory) 55. Signals and systems (Year 2, Obligatory) 56. Microprocessors (Year 2, Obligatory) 57. Control Theory 1 (Year 3, Obligatory) 58. Probability and Statistics (Year 3, Obligatory) 59. Programmable Logical Controllers (Year 3, Obligatory) 60. Control Theory 2 (Year 4, Obligatory) 61. Virtual and Augmented Reality (Year 4, Obligatory) 62. Communication Protocols (Year 4, Obligatory) 63. A large pool of 75 Major Elective courses (each of 6 ECTs)
Teaching and Research AIR Labs	NA
Research Groups	NA – Two centers are available in the institution: 3. The Center for Intellectual Property and Technology Transfer (supported with a grant under The European Commission’s Seventh Framework Programme) 4. The Center for BioEngineering
Collaboration with Industry <i>(List of sample projects)</i>	NA
Summary and Notes	

Number	9	
Program Name	<i>Mechatronics, B.Sc.</i>	
University	University of Stuttgart	
Country	Germany	
URL	https://www.uni-stuttgart.de/en/study/bachelor-programs/mechatronics-b.sc./	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input checked="" type="checkbox"/> General program with Data Science component <input checked="" type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	5400	
AI Credit Hours	450 obligatory + 90 elective	
Data Science Credit Hours	1260 obligatory + 900 elective	
Robotics Credit Hours	1530 obligatory + 1800 elective	
AI Courses in Curriculum	34. Introduction to Feedback Control Systems (obligatory) 6 CP 35. Control Engineering (obligatory) 6 CP 36. Project Work: Engineering Cybernetics (obligatory) 3 CP 37. Multivariable Control (elective) 3CP	
Robotics Courses in Curriculum	1. System Dynamics (obligatory) 3 CP 2. Machine Dynamics (obligatory) 6 CP 3. Electrical Drives (elective) 6 CP 4. Technologies and Methods of Software Systems I (elective) 6 CP 5. Information Technology in Production (elective) 6 CP 6. Programming and Software Development (obligatory) 9 CP 7. Applied Mechanics I (obligatory) 6 CP 8. Applied Mechanics II + III (obligatory) 12 CP 9. Numerical Methods for Dynamics (obligatory) 6 CP 10. Industrial Automation I (obligatory) 6 CP 11. Digital Signal Processing (elective) 6 CP 12. Design and manufacturing of micro- and nanoelectronic systems (elective) 6 CP 13. Control Technology of Machine Tools and Industrial Robots (elective) 6 CP 14. Dynamics of Mechanical Systems (elective) 6 CP 15. IT architectures for production applications (elective) 6 CP 16. Non-linear Dynamics (elective) 6 CP 17. Dynamics of Discrete-Event Systems (elective) 6 CP 18. Measurement Engineering (obligatory) 3 CP	

Number	9
Program Name	<i>Mechatronics, B.Sc.</i>
Fundamental Courses to Support AIR	<ol style="list-style-type: none"> 1. Advanced Mathematics I-III (obligatory) 27 CP 2. Foundations of Software Engineering (obligatory) 6 CP 3. Basics of Information Processing (elective) 6 CP 4. Modeling, Simulation and Optimization Processes (elective) 6 CP 5. Data Structures and Algorithms (obligatory) 9 CP 6. Simulation Methods for Dynamic Systems (elective) 6 CP 7. Stochastic Systems (elective) 6 CP 8. Technical Computer Science I (elective) 6 CP
Teaching and Research AIR Labs	<ol style="list-style-type: none"> 1. Laboratory – Institute of Engineering and Computational Mechanics 2. Laboratory – Institute for Systems Theory and Control 3. Practical Trainings – Institute for System Dynamics 4. Laboratory – Institute for Control Engineering of Machine Tools and Manufacturing Units 5. Laboratory – Institute for Nonlinear Mechanics
Research Groups	<ol style="list-style-type: none"> 1. Institute of Engineering and Computational Mechanics 2. Institute for Nonlinear Mechanics 3. Institute for Systems Theory and Control 4. Institute for System Dynamics 5. Institute for Control Engineering of Machine Tools and Manufacturing Units
Collaboration with Industry <i>(List of sample projects)</i>	Only exemplarily: ZF Friedrichshafen, Bosch, Porsche, Daimler, Trumpf, Rexroth, Festo, ...
Summary and Notes	
<p>This study program is interdisciplinary in nature to prepare students to master any complex technological process. However, there is a strong emphasis on robotics, also in the obligatory courses. This program covers much of the basic knowledge in robotics and is therefore recommended as a robotics bachelor's degree at the University of Stuttgart. Additionally, students can choose courses to gain further in-depth knowledge also in the field of AI. Notice that the first four semesters aim to build a strong theoretical background for students. After that, a wide range of specialization subjects is offered.</p>	

Number	10	
Program Name	<i>Engineering Cybernetics, B.Sc.</i>	
University	University of Stuttgart	
Country	Germany	
URL	https://www.student.uni-stuttgart.de/en/study-programs/Engineering-Cybernetics-B.Sc-00001./	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input checked="" type="checkbox"/> General program with Data Science component <input checked="" type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	5400	
AI Credit Hours	360 obligatory + 990 elective	
Data Science Credit Hours	990 obligatory + 3150 elective	
Robotics Credit Hours	1350 obligatory + 2430 elective	
AI Courses in Curriculum	<ol style="list-style-type: none"> 1. Introduction to Feedback Control Systems (obligatory) 6 CP 2. Introduction to Engineering Cybernetics (obligatory) 3 CP 3. Multivariable Control (obligatory) 3 CP 4. Control Engineering (elective) 6 CP 5. Basic Principles of Artificial Intelligence (elective) 6 CP 6. Computer Science II (elective) 6 CP 7. Nonlinear Programming (elective) 3 CP 8. Machine Learning (elective) 6 CP 9. Reinforcement Learning (elective) 6 CP 	

Number	10
Program Name	<i>Engineering Cybernetics, B.Sc.</i>
Robotics Courses in Curriculum	<ol style="list-style-type: none"> 1. Machine Dynamics (elective) 6 CP 2. Dynamics of Mechanical Systems (elective) 6 CP 3. Applied Mechanics I-III (obligatory) 18 CP 4. Applied Mechanics IV (elective) 6 CP 5. Numerical Methods for Dynamics (obligatory) 6 CP 6. Measurement Engineering I (obligatory) 3 CP 7. Non-linear Dynamics (elective) 6 CP 8. Dynamics of Discrete-Event Systems (elective) 6 CP 9. Electrical Signal Processing (obligatory) 6 CP 10. Introduction to Electrical Engineering I (obligatory) 3 CP 11. Introduction to Electrical Engineering II (elective) 3 CP 12. System Dynamics and Simulation Methods for Dynamic Systems (obligatory) 9 CP 13. Measurement Engineering in Automation (elective) 3 CP 14. Robotics I (elective) 6 CP 15. Robots – Applications in Service Robotics (elective) 3 CP 16. Control Technology of Machine Tools and Industrial Robots (elective) 6 CP 17. Flight Mechanics (elective) 3 CP 18. Flight Control (elective) 3 CP 19. Satellite Control (elective) 3 CP 20. Modeling and Simulation in Mechatronics (elective) 6 CP 21. Selected Problems of Mechanics (elective) 3 CP 22. Electrical Drive Systems (elective) 12 CP

Number	10
Program Name	<i>Engineering Cybernetics, B.Sc.</i>
Fundamental Courses to Support AIR	<ol style="list-style-type: none"> 1. Advanced Mathematics I-III (obligatory) 27 CP 2. Probability Theory and Statistics (obligatory) 6 CP 3. Analysis I-III (elective) 27 CP 4. Linear Algebra and Analytical Geometry 1 (elective) 9 CP 5. Stochastic Systems (elective) 6 CP 6. Stochastic processes and modeling (elective) 6 CP 7. Real-Time Data Processing (elective) 6 CP 8. Parallel Systems (elective) 6 CP 9. Introduction to Software Engineering (elective) 6 CP 10. Foundations of Software Engineering (elective) 6 CP 11. Computer Vision (elective) 6 CP 12. Computer Networks (elective) 6 CP 13. Technologies and Methods of Software Systems I (elective) 6 CP 14. IT architectures for production applications (elective) 6 CP 15. Introduction to Information Security (elective) 6 CP 16. Control Architectures and Communication Technology (elective) 3 CP
Teaching and Research AIR Labs	<ol style="list-style-type: none"> 1. Laboratory – Institute of Engineering and Computational Mechanics 2. Laboratory – Institute for Systems Theory and Control 3. Practical Trainings – Institute for System Dynamics 4. Laboratory – Institute for Control Engineering of Machine Tools and Manufacturing Units 5. Laboratory – Institute for Nonlinear Mechanics 6. Machine Learning & Robotics Lab - IPVS
Research Groups	<ol style="list-style-type: none"> 1. Institute of Engineering and Computational Mechanics 2. Institute for Systems Theory and Control 3. Institute for System Dynamics 4. Institute for Control Engineering of Machine Tools and Manufacturing Units 5. Institute for Nonlinear Mechanics 6. Institute for Parallel and Distributed Systems
Collaboration with Industry <i>(List of sample projects)</i>	Only exemplarily: ZF Friedrichshafen, Bosch, Porsche, Daimler, Trumpf, Rexroth, Festo, ...
Summary and Notes	

Number	10
Program Name	<i>Engineering Cybernetics, B.Sc.</i>
<p>The emphasis of this program is more on a strong theoretical and mathematical background of engineering problems. Especially general system dynamics and control problems are covered. However, there is a strong overlap with the courses offered in the Mechatronics program, although many of them are elective courses for this program. In addition, further courses in Data Science and AI are offered.</p>	

Number	11	
Program Name	<i>Simulation Technology, B.Sc.</i>	
University	University of Stuttgart	
Country	Germany	
URL	https://www.uni-stuttgart.de/en/study/study-programs/Simulation-Technology-B.Sc./	
Program Nature	<input checked="" type="checkbox"/> General program with AI component <input checked="" type="checkbox"/> General program with Data Science component <input checked="" type="checkbox"/> General program with Robotics component	<input type="checkbox"/> Specialized program in AI <input type="checkbox"/> Specialized program in Data Science <input type="checkbox"/> Specialized program in Robotics
Total Credit Hours	5400	
AI Credit Hours	450 obligatory + 3780 elective	
Data Science Credit Hours	1800 obligatory + 9720 elective	
Robotics Credit Hours	540 obligatory + 5220 elective	
AI Courses in Curriculum	<ol style="list-style-type: none"> 1. Introduction to Simulation Technology 1 (obligatory) 6 CP 2. Introduction to Computer Science (obligatory) 9 CP 3. Basic Principles of Artificial Intelligence (elective) 6 CP 4. Theoretical Computer Science (elective) 6 CP 5. Algorithmics (elective) 6 CP 6. Theoretical Fundamentals of Computer Science (elective) 12 CP 7. Algorithms and Computability (elective) 6 CP 8. Introduction to Feedback Control Systems (elective) 6 CP 9. Feedback Control Systems and Control Engineering (elective) 6 CP 10. Concepts of Automatic Control (elective) 6 CP 11. Robust Control (elective) 6 CP 12. Nonlinear Control (elective) 6 CP 13. Detection and Pattern Recognition (elective) 6 CP 14. Computer Vision (elective) 6 CP 15. Machine Learning (elective) 6 CP 16. Programming Paradigms (elective) 6 CP 17. Multivariable Control (elective) 3 CP 18. Computed Networks (elective) 6 CP 19. Distributed Systems (elective) 6 CP 20. Linear Control Theory (elective) 9 CP 21. Statistical Learning and Stochastical Control (elective) 6 CP 22. Deep learning (elective) 6 CP 	

Number	11
Program Name	<i>Simulation Technology, B.Sc.</i>
Robotics Courses in Curriculum	<ol style="list-style-type: none"> 1. Engineering Mechanics I-II (obligatory) 12 CP 2. Modelling for complex systems (obligatory) 6 CP 3. Basic Principles of Modeling and Simulation (elective) 6 CP 4. Modeling (elective) 6 CP 5. Numerical Methods for Dynamics (elective) 6 CP 6. Simulation Methods for Dynamics Systems (elective) 6 CP 7. Electrical Signal Processing (elective) 6 CP 8. Real-Time Data Processing (elective) 6 CP 9. Engineering Mechanics III (elective) 6 CP 10. Dynamic Systems (elective) 9 CP 11. Applied Mechanics IV for Mathematics (elective) 6 CP 12. Advanced Mechanics I-II (elective) 12 CP 13. Machine Dynamics (elective) 6 CP 14. Numerical Simulation (elective) 6 CP 15. Aeronautical Engineering and Aeronautical Propulsion (elective) 6 CP 16. Vehicle Dynamics (elective) 3 CP 17. Flexible Multibody Systems (elective) 6 CP 18. Optimization of Mechanical Systems (elective) 3 CP 19. Non-linear Dynamics (elective) 6 CP 20. Dynamics of Discrete-Event Systems (elective) 6 CP 21. Engineering Mechanics III (elective) 9 CP 22. Infinite Dimensional Dynamical Systems (elective) 9 CP 23. Simulation Methods in Physics (elective) 6 CP 24. System Dynamics (elective) 3 CP 25. System Concept and System Programming (elective) 6 CP 26. Basic Principles of Modeling and Simulation (elective) 6 CP 27. Signals and Systems (elective) 6 CP 28. Robotics I (elective) 6 CP 29. Dynamics of Mechanical Systems (elective) 6 CP 30. Space Systems (elective) 6 CP

Fundamental Courses to Support AIR	<ol style="list-style-type: none"> 1. Analysis I-II (obligatory) 18 CP 2. Advanced Analysis for Simulation Technology I (obligatory) 9 CP 3. Advanced Analysis for Simulation Technology II (obligatory) 6 CP 4. Data Structures and Algorithms (obligatory) 6 CP 5. Fundamentals of Experimental Physics I-II (obligatory) 15 CP 6. Statistics and Optimization for Simulation Technology (obligatory) 6 CP 7. Numerical Mathematics 1 (elective) 9 CP 8. Numerical Mathematics (elective) 9 CP 9. Numerical Fundamentals (elective) 6 CP 10. Numerical Mathematics for SimTech (elective) 6 CP 11. Numerical and Stochastic Fundamentals (elective) 9 CP 12. Linear Algebra and Analytical Geometry I-II (elective) 18 CP 13. Probability Calculus (elective) 9 CP 14. Higher Analysis (elective) 9 CP 15. Functional Analysis (elective) 9 CP 16. Partial Differential Equations (elective) 9 CP 17. Computability and Complexity (elective) 6 CP 18. Stochastic Systems (elective) 6 CP 19. Discrete Optimization (elective) 6 CP 20. Nonlinear Partial Differential Equations (elective) 9 CP 21. Introduction to the numerics of partial differential equations (elective) 9 CP 22. Advanced Numerics of Partial Differential Equations (elective) 9 CP 23. Computer Basics (elective) 6 CP 24. Fundamentals of Experimental Physics III-IV (elective) 15 CP 25. Theoretical Physics I-IV (elective) 36 CP 26. Computer Organization (elective) 12 CP 27. Fundamentals of Scientific Computing (elective) 6 CP 28. High Performance Computing (elective) 6 CP 29. Stochastic processes and modeling (elective) 6 CP 30. Analytical Methods (elective) 6 CP 31. Theoretical and Methodological Foundations of Autonomous Systems (elective) 6 CP 32. Functional Analysis (elective) 9 CP 33. Parallel Numerics (elective) 6 CP 34. Stochastic Processes II (elective) 9 CP 35. Introduction to stochastic partial differential equations (elective) 6 CP
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Number	11
Program Name	<i>Simulation Technology, B.Sc.</i>
	36. Introduction into Chaostheory (elective) 6 CP 37. Numerical Simulation (elective) 6 CP 38. Asymptotic Analysis (elective) 9 CP 39. Foundations of Computer Engineering (elective) 6 CP 40. Theoretical Computer Science III (elective) 6 CP 41. Data Processing for Engineers and Scientists (elective) 6 CP 42. Numerical Mathematics for Differential Equations (elective) 9 CP 43. Mathematical Image Processing (elective) 9 CP
Teaching and Research AIR Labs	1. Laboratory – Institute of Engineering and Computational Mechanics 2. Laboratory – Institute for Systems Theory and Control 3. Practical Trainings – Institute for System Dynamics 4. Laboratory – Institute for Control Engineering of Machine Tools and Manufacturing Units 5. Laboratory – Institute for Nonlinear Mechanics 6. Machine Learning & Robotics Lab – IPVS 7. SOLA – Software Lab University of Stuttgart
Research Groups	1. Institute of Engineering and Computational Mechanics 2. Institute for Systems Theory and Control 3. Institute for System Dynamics 4. Institute for Control Engineering of Machine Tools and Manufacturing Units 5. Institute for Nonlinear Mechanics 6. Institute for Parallel and Distributed Systems
Collaboration with Industry <i>(List of sample projects)</i>	Only exemplarily: ZF Friedrichshafen, Bosch, Porsche, Daimler, Trumpf, Rexroth, Festo, ...
Summary and Notes	
The Simulation Technology program is very interdisciplinary and free-form. Thus, the students can choose from a wide range of courses and thus also take courses which cover robotics and AI topics. Notice that this program is very research oriented.	