

EIT Digital Master School

Autonomous Systems

What can I study at the entry and exit points?



Inhoud

Entry points.....	2
Aalto University (Aalto), Finland.....	3
Budapest University of Technology and Economics (BME), Hungary.....	1
KTH Royal Institute of Technology, Sweden.....	1
University of Trento (UNITN), Italy.....	1
Université Côte d'Azur (UCA), France.....	1
Exit points.....	2
Aalto University (Aalto), Finland.....	3
Programme Lead: Quan Zhou, quan.zhou@aalto.fi.....	3
KTH Royal Institute of Technology, Sweden.....	5
University of Trento (UNITN), Italy.....	6
EURECOM, France.....	8
Eötvös Loránd University (ELTE), Hungary.....	9

Entry points

1st year, common courses

Academic year 2022/2023

[Aalto University \(Aalto\), Finland](#)

Programme Lead: Quan Zhou, quan.zhou@aalto.fi

ENTRY - FIRST SEMESTER (31 ECTS)

Compulsory major courses (19-24 ECTS)

- SCI-E1010: Introduction course for Master's students: Academic Skills - 1 ECTS
- LC-xxxx: Language course: Compulsory degree requirement, both oral and written requirements - 3 ECTS
- ELEC-D1320 : Robotics - 5 ECTS
- ELEC-E8103: Modelling, Estimation and Dynamic Systems - 5 ECTS
- CS-E4710*: Machine Learning: Supervised Methods - 5 ECTS

Select one of the following based on your previous studies (ELEC-C8201 if no previous study in automatic control)

- ELEC-E8101: Digital and Optimal Control - 5 ECTS (autumn)
- ELEC-C8201: Control and automation - 5 ECTS (spring)

*New course starting in 2020-2021

Compulsory I&E Courses (7 ECTS)

- CS-E5120: Introduction to Digital Business and Venturing - 3 ECTS
- CS-E5130: Digital Business Management - 4 ECTS

Optional major courses (0-5 ECTS)

- ELEC-E8125: Reinforcement learning - 5 ECTS
- ELEC-E8740: Basic of sensor fusion - 5 ECTS
- CS-E4850: Computer Vision - 5 ECTS
- CS-E5710: Bayesian Data Analysis - 5 ECTS
- ELEC-E8127: Special assignment in automation technologies - 1-10 ECTS

ENTRY - SECOND SEMESTER (29 ECTS)

Compulsory major courses (0-5 ECTS)

Select one of the following based on your previous studies (ELEC-C8201 if no previous study in automatic control)

- ELEC-E8101: Digital and Optimal Control - 5 ECTS (autumn)
- ELEC-C8201: Control and automation - 5 ECTS (spring)

Compulsory I&E Courses (17 ECTS)

- TU-E4100: Startup Experience - 9 ECTS
- CS-E5140: Global Business in the Digital Age - 4 ECTS
- CS-E5430: ICT Innovation Summer School - 4 ECTS

Optional major courses (7-12 ECTS)

- ELEC-C8201: Control and automation* - 5 ECTS
- ELEC-E8111: Autonomous Mobile Robots - 5 ECTS
- ELEC-E8115: Micro- and Nano Robotics - 5 ECTS
- ELEC-E8123: Networked Control Systems - 5 ECTS
- ELEC-E8126: Robotic manipulation - 5 ECTS
- ELEC-E8408: Embedded Systems Development - 5 ECTS
- ELEC-E5710: Sensors and Measurement Methods - 5 ECTS
- MS-E2112: Multivariate Statistical Analysis - 5 ECTS
- ELEC-E8127: Special assignment in automation technologies - 1-10 ECTS
- CS-E4890: Deep Learning- 5 ECTS

Budapest University of Technology and Economics (BME), Hungary

Programme lead: Bálint Kiss - bkiss@iit.bme.hu

ENTRY - FIRST SEMESTER (30/31 ECTS)

Compulsory major courses (11/12 credits)

- Natural science course I (3 or 4 credits, selected from the list below)
- [Autonomous robots and vehicles](#) (4 credits)
- Modelling and identification of dynamical systems lab (4 credits)

Optional major courses (students select two for 8 credits)

- [Development of software applications](#) (4 credits)
- [Design and integration of embedded systems](#) (4 credits)
- Localization and mapping (4 credits)

Compulsory I&E courses (11 credits)

- I&E Basics (6 credits)
- Business development laboratory I (3 credits)
- I&E Elective (2 credits)

Catch-up courses (pending approval based on the applicant's background)

- Artificial intelligence (3 credits)
- [Industrial control](#) (4 credits)

ENTRY - SECOND SEMESTER (29 ECTS)

Compulsory major courses (15/14 credits)

- Natural science course II (4 or 3 credits, selected from the list below)
- Embedded systems security (4 credits)
- [Artificial intelligence-based control](#) (4 credits)
- Project laboratory (3 credits)

Optional major courses (students select one for 4 credits)

- [Computer vision systems](#) (4 credits)
- [Software technology for embedded systems](#) (4 credits)

Compulsory I&E courses (11 credits)

- Business development laboratory II (5 credits)
- I&E Elective (2 credits)
- Summer school courses (4 credits)

Natural science courses (I and II, must be selected from this list)

- Stochastics (3 credits, Fall semester)
- Applied algebra and mathematical logic (4 credits, Fall semester)
- [Measurement theory](#) (4 credits, Spring semester)
- [Communication theory](#) (4 credits, Spring semester)

- Linear algebra (3 credits, Spring semester)
- [Combinatorial optimization](#) (3 credits, Spring semester)

KTH Royal Institute of Technology, Sweden

Programme Lead: Mihhail atskin, misha@kth.se

ENTRY - FIRST SEMESTER (36 ECTS)

Compulsory courses (30 ECTS)

- DD2410 [Introduction to robotics](#) (7.5 ECTS)
- DD2421 [Machine learning](#) (7.5 ECTS)
- ID2209 [Distributed artificial intelligence and intelligent agents](#) (7.5 ECTS)
- II2202 [Research methodology and scientific writing](#) (7.5 ECTS)

I&E (6 ECTS)

- ME2072 [Entrepreneurship for engineers](#) (6 ECTS)

ENTRY - SECOND SEMESTER (min. 24 ECTS)

No compulsory major courses

I&E (13 ECTS)

- ME2073 [Business development lab of entrepreneurship engineers](#) (9 ECTS)
- ME2078 [Summer course – entrepreneurship for engineers](#) (4 ECTS)

I&E Conditionally Compulsory course (7.5 ECTS)

- ME2062 [Technology-based Entrepreneurship](#) (7.5 ECTS)
- ME2094 [Internet Marketing](#) (7.5 ECTS)
- ME2095 [e-Business Strategies](#) (7.5 ECTS)

Elective courses

- DD2423 [Image analysis and computer vision](#) (7.5 ECTS)
- EL2450 [Hybrid and embedded control systems](#) (7.5 ECTS)
- DD2424 [Deep learning in data science](#) (7.5 ECTS)
- EQ2321 [Speech and audio processing](#) (7.5 ECTS)
- DD2380 [Artificial intelligence](#) (6 ECTS)
- EQ2871 [Cyber-physical networking](#) (7.5 ECTS)
- EL1010 [Automatic control, general course](#) (6 ECTS)
- IL2206 [Embedded systems](#) (7.5 ECTS)
- II2302 [Sensor based systems](#) (7.5 ECTS)

- EL2520 [Control theory and practice, advanced course](#) (7.5 ECTS)
- EQ2425 [Analysis and search of visual data](#) (7.5 ECTS)
- EQ2341 [Pattern recognition and machine learning](#) (7.5 ECTS)
- II2205 Stochastic Simulation (7.5 ECTS)
- II1305 [Project in Information and Communication Technology](#) (7.5 ECTS)

[University of Trento \(UNITN\), Italy](#)

Programme Lead: Daniele Fontanelli, daniele.fontanelli@unitn.it

ENTRY - FIRST SEMESTER (33 ECTS)

Compulsory major courses (21 ECTS)

- 140506 Robotic perception and action (9 ECTS)
- 140440 Industrial robotics (6 ECTS)
- 145062 Machine learning (6 ECTS)

I&E course (12 ECTS)

- 146004 Digital production and logistics systems
 - Mod.1** - Design of digital production and assembly systems (6 ECTS)
 - Mod.2** - Logistics and warehouse management (6 ECTS)

ENTRY - SECOND SEMESTER (27 ECTS)

Compulsory major courses (9 ECTS)

- 140469 Modeling and simulation of mechatronic systems (9 ECTS)

Suggested elective major courses (select one course)

- 145774 Automatic control (6 ECTS)
- 146008 Decision and risk analysis (6 ECTS)
- 145958 Network dynamics (6 ECTS)
- 146040 Design methods for Unmanned Vehicles (6 ECTS)
- 140474 Computer vision (6 ECTS)
- 145764 Deep learning (6 ECTS)

I&E courses (12 ECTS)

- 145288 Business development laboratory (9 ECTS)
- Summer school (3 ECTS)

[See Syllabus](#)

Université Côte d'Azur (UCA), France

Program Lead: Ducard Guillaume, Guillaume.Ducard@univ-cotedazur.fr

UCA offers a study program at Master M1 level in Autonomous Systems. All the fundamental aspects of modeling dynamic systems, parameter and state estimation, control, artificial intelligence and robotics are covered.

ENTRY - FIRST SEMESTER

- Basics in I&E (3 ECTS)
- Business Intelligence (3 ECTS)
- Business Development Lab Part1 (3 ECTS)

Compulsory courses (12 ECTS)

- EIEL931G [Robotics: fundamentals, sensor modeling and fusion](#): fundamentals, sensor modeling and fusion (2 ECTS)
- Robotics Project (2 ECTS)
- [EIEL933G](#) Embedded Hardware and Software for Self-driving Cars (GSE5) (2 ECTS)
- Preparation to the Industrial Project (3 ECTS)
- Communication 5G (3 ECTS)

Elective courses

- EIEL923G [Embedded Linux](#) (2 ECTS)
- Advanced Control and Estimation for AS (1 ECTS)
- Architecture IoT
- Mobile Communications: 2G, 3G, 4G (2 ECTS)
- Mobile Communications: Technology of connected objects (1 ECTS)
- Refresher in Maths and stats (2 ECTS)
- Wireless SensorNetwork (2 ECTS)
- Embedded Systems Project (6 ECTS)
- Embedded Artificial Intelligence (2 ECTS)

Innovation and Entrepreneurship I&E

ENTRY - SECOND SEMESTER

Compulsory courses (12 ECTS)

- System Modeling (1 ECTS)
- [EIEL822 Digital Control](#) (2 ECTS)
- Artificial Intelligence: Optimization and Machine Learning (3 ECTS)
- EIEL841 Industrial semester project (3 ECTS)
- 3DMVL: 3D Machine Vision and Learning (2 ECTS)
- Introduction to Robot Operating System (ROS) and Gazebo (1 ECTS)

Elective courses

- Embedded Java (2 ECTS)
- Embedded C++ (2 ECTS)
- Applied Estimation to Autonomous Systems (1 ECTS)
- Sensors, Actuators and Neural Networks (3 ECTS)
- Refresher in Automatic Control (1 ECTS)

Elective Innovation and Entrepreneurship I&E2 (6 ECTS)

- Data Science for business (3 ECTS)
- Innovation management in large organizations (3 ECTS)
- Digital Innovation in Fintech (3 ECTS)
- Digital cities (3 ECTS)

Innovation and Entrepreneurship I&E3

- [Business Dev. Lab. Part 2](#) (5 ECTS)
- Summer School (organized by IET Digital) (4 ECTS)

Exit points

**2nd year,
Specialisation**

Academic year 2023/2024

Aalto University (Aalto), Finland

Programme Lead: Quan Zhou, quan.zhou@aalto.fi

SPECIALIZATION

Aalto University offers specialisation in **Robotics and Artificial Intelligence**. The courses combine both electrical engineering and computer science. Elective courses include autonomous mobile robots, micro- and nano robotics, computer vision, robotic vision, and machine learning. The students will learn how to build autonomous, intelligent robots and robotic systems.

The specialisation is offered by the Department of Electrical Engineering and Automation. The department combines expertise from microsystems, electrical engineering and automation. One of the four focus areas is control, robotics and autonomous systems. The total size of the staff is 180, including 16 tenured professors.

LIST OF COURSES - FIRST SEMESTER

Compulsory major courses (4 ECTS)

- SCI-E1010: Introduction course for Master's students: Career and working life skills - 1 ECTS
- LC-xxxx: Language course: Compulsory degree requirement, both oral and written requirements - 3 ECTS

Compulsory I&E Course (6 ECTS)

- CS-E5425: I&E Study Project - 6 ECTS
-

Optional major courses (20 ECTS)

- ELEC-E8101: Digital and Optimal Control - 5 ECTS - Autumn
- ELEC-E8115: Micro- and Nano Robotics - 5 ECTS - Spring
- ELEC-E8116: Model-Based Control Systems - 5 ECTS - Autumn
- ELEC-E8125: Reinforcement learning - 5 ECTS - Autumn
- ELEC-E8704: Basic of sensor fusion - 5 ECTS - Autumn
- ELEC-E7120: Wireless Systems - 5 ECTS - Autumn
- CS-C3180: Software Design and Modelling - 5 ECTS Autumn
- CS-E4190: Cloud Software and Systems - 5 ECTS - Autumn
- CS-E4650: Methods of Data Mining -5 ECTS -Autumn
- CS-E4850: Computer Vision - 5 ECTS - Autumn
- CS-E4890: Deep Learning - 5 ECTS - Spring
- CS-E4830: Kernel Methods in Machine Learning - 5 ECTS - Spring

- CS-E5710: Bayesian Data Analysis - 5 ECTS - Autumn
- ELEC-E8127: Special assignment in automation technologies - 1-10 ECTS - Autumn/Spring

SECOND SEMESTER: Master's thesis (30 ECTS)

KTH Royal Institute of Technology, Sweden

Programme Lead: Mihhail atskin, misha@kth.se

SPECIALIZATION

KTH offers a specialisation in **Intelligent Autonomous Systems**. The specialisation emphasises the combination of fundamental principles of computer science and artificial intelligence with autonomous (software and robotics) systems design. KTH will offer courses in the area of distributed artificial intelligence and intelligent agents, machine learning, scalable machine learning and deep learning, and deep learning in data science as well as courses in robotics and software engineering for data intensive systems. The offered courses provide students with both understanding of intelligent autonomous systems and knowledge of methods for developing such systems.

The specialisation is offered by the School of Electrical Engineering and Computer Science. The school provides a very broad expertise in many areas related to electrical engineering, control, software engineering, artificial intelligence, robotics and computer science. The school employs 188 faculty members including 88 tenure track professors.

Departments who will be involved into teaching in the program include: Computer Science department, Software and Computer Systems department, department of Robotics, department of Automatic Control and department of Communication Networks.

LIST OF COURSES - FIRST SEMESTER

Compulsory courses (7.5 ECTS)

- II2202 [Research methodology and scientific writing](#) (7.5 ECTS)

Elective courses (select 15 ECTS)

- ID2223 [Scalable machine learning and deep learning](#) (7.5 ECTS)
- ID2209 [Distributed artificial intelligence and intelligent agents](#) (7.5 ECTS)
- EL2320 [Applied estimation](#) (7.5 ECTS)
- EL2820 [Modelling of dynamical systems](#) (7.5 ECTS)
- IL2206 [Embedded systems](#) (7.5 ECTS)

I&E (6 ECTS)

- ME2096 [Innovation study project](#) (6 ECTS)

SECOND SEMESTER: Master's thesis (30 ECTS)

University of Trento (UNITN), Italy

Programme Lead: Daniele Fontanelli, daniele.fontanelli@unitn.it

SPECIALIZATION

UniTN offers a specialisation in **Autonomous Robotics Systems**. The specialisation aims at offering the tools and the theoretical foundations to tackle the new challenges of the next generation of autonomous systems.

Once limited to small and constrained industrial environment, robotic technologies have now become pervasive and are currently one of the main driver of innovation in many areas. Two market segments in which this evolution is more apparent is that of autonomous driving cars and of service robotics. Similarly, the revolution of the Industry 4.0 has changed the landscape also for industrial applications. Modern manufacturing requires unprecedented levels of flexibility, the ability to react to unforeseen events, lean and on-demand production. These changes have put a strain on "classic" technologies, giving birth to a new wave of industrial robots, more intelligent, more flexible and more interconnected than ever.

In order to face the demanding challenges of modern robotics, professionals are required to have a large number of abilities such as can be found in broad and multifaceted curriculum. In this challenging and exciting scenario, UniTN offers an education pathway that rests on four main pillars: mastering optimal control techniques and their applications to automotive and robot systems, applying control and measurement algorithms with a number of heterogeneous source of information, developing planning and decision making mechanisms that enable the robot to optimise its operation and react to unforeseen events, develop scalable and robust software architectures that make the most of the existing communication infrastructure. Elective courses include Computer vision, Industrial Robotics, Real time operating systems and Wireless mesh and vehicular networks.

The specialisation is offered by the Department of Industrial Engineering (DII) and the Department of Engineering and Computer Science (DISI), both at the University of Trento. DII provides a very broad expertise in many areas related to industrial engineering, industrial and service robotics, dynamics, modelling and control of vehicles, while DISI offers a wide knowledge on software engineering, artificial intelligence, decision making and computer science.

LIST OF COURSES - FIRST SEMESTER

Compulsory major courses (18 ECTS)

- 146042 Distributed robot perception (6 ECTS)
- 146043 Robot Planning and its application (6 ECTS)
- 146038 Intelligent vehicles and autonomous driving (6 ECTS)

Suggested elective major courses (select 6 ECTS)

- 145781 Advanced optimization-based robot control (6 ECTS)

- 145301 Project course (6 ECTS)
- 140473 Quality and Innovation Engineering (6 ECTS)
- 140502 Embedded systems (6 ECTS)
- 145883 Sensing and Radar Technologies (6 ECTS)

I&E course (6 ECTS)

- 145623 Innovation and entrepreneurship studies in ICT (6 ECTS)

[See Syllabus](#)**SECOND SEMESTER: Master's thesis (30 ECTS)**

EURECOM, France

scientific coordinator: Prof. Raphaël Troncy and Prof. Paolo Papotti

administrative coordinator: Philippe Benassi - contact: master-eit-aus@eurecom.fr

SPECIALIZATION

EURECOM is offering a specialisation in **Sensing, Communicating and Processing Big Data for Autonomous Systems**. This specialisation aims at describing the methods and tools to process and analyse data from sensors (big data integration, semantic interoperability, data mining and analytics) and at understanding the communication mechanisms adapted to the sensors' constraints (low energy consumption, limited computing capacities, etc.). Consequently, this master specialisation is at the crossroad between communication systems and data science skills.

LIST OF COURSES - FIRST SEMESTER

UE Data Processing and Architecture [5 ECTS]

- MALIS - Machine Learning and Intelligent System (5 ECTS)
- WebInt - Interaction Design and Development of Modern Web Applications (2.5 ECTS)
- MobMod - Mobility Modeling (2.5 ECTS)
- CompArch - Computer architecture (5 ECTS)

UE Software & Systems [10 ECTS]

- Clouds - Distributed Systems and Cloud Computing (5 ECTS)
- MobSys - Mobile communication systems (5 ECTS)
- UMLEmb - Designing embedded systems with UML (2,5 ECTS)
- Stand - Standardization activities (2.5 ECTS)
- NetMod - Network Modeling (5 ECTS)
- MPC - Multiparty Computation and Blockchains (2,5 ECTS)
- MobiSec - Mobile Systems and Smartphone Security (5 ECTS)
- MobCom - Mobile communication techniques (5 ECTS)

UE I & E [6 ECTS]

- Fundamental in innovation and entrepreneurship (6 ECTS)

Semester Project [8 ECTS]

UE Languages [1]

SECOND SEMESTER: Master's thesis (30 ECTS)

Example of recent [past semester projects](#):

- Flying Robots for Future Wireless Networks Beyond 5G
- Automated code generation for IoTs
- Social Mobility Modeling in Urban Environments

- Self-driving MarioKart with TensorFlow
- Connected Cars? Implementation of LTE Device-to-Device (LTE D2D) on OAI
- Guard drone
- Finding IoT Networks in the Wild
- Security and Privacy for Internet of Things

Eötvös Loránd University (ELTE), Hungary

Programme Lead: Zoltán Istenes, zoltan.istenes@eitdigital.eu

SPECIALIZATION

ELTE offers a specialisation in **Computer Science for Autonomous Driving**. The specialisation comprises core courses on the design, implementation, operation and maintenance of software for self-driving vehicles. Students get thorough and up-to-date knowledge in the fields of artificial intelligence and machine learning.

The specialisation provides comprehensive knowledge of tools and methods for computer perception, especially in 3D vision, image and video analysis, sensor data aggregation. Students can also learn fundamentals and applications of computer graphics and computational geometry. Our courses cover a wide spectrum of topics related specifically to current challenges of autonomous vehicles, and they prepare students for a variety of career options in software development in autonomous systems.

Elective courses include security of autonomous systems, design and analysis of algorithms, spatial information systems, legal framework for autonomous vehicles. Our vision is an equal emphasis on fundamental principles and practical skills. To this end, we combine the training of students with the research activities at the university, and we invite our best students into R&D&I work in one of our research labs. These long-running, innovative software-engineering projects are carried out in cooperation with industrial partners like Ericsson and Bosch. In this specialisation students can choose lab work as an elective course and work together in international teams on real problems of autonomous systems. ELTE offers students the opportunity to explore and develop their careers through professional practice at partner companies.

ELTE endeavours to provide a supportive and enjoyable atmosphere for learning - we provide helpdesk and extensive assistance during studies.

LIST OF COURSES - FIRST SEMESTER

Compulsory courses (20 ECTS)

- IPM-18AUTADLEG Applied deep learning (5 ECTS)
- IPM-18AUTSCTEG System and Control Theory (5 ECTS)
- IPM-18AUTIVPEG Image and Video Processing (5 ECTS)
- IPM-18AUTSSFEG 3D sensing and sensor fusion (5 ECTS)

Elective courses (select 4 ECTS)

- IPM-18AUTSTEG Software technology (5 ECTS)
- IPM-18AUTPME Project Management (2 ECTS)
- IPM-18AUTPHFTG Human factors in traffic environment (2 ECTS)
- IPM-18AUTLFADE Legal framework of autonomous vehicles (2 ECTS)

- IPM-18AUTDAAEG Design and analysis of algorithms (5 ECTS)
- IPM-18AUTISPE Image and Signal Processing (2 ECTS)
- PM-18AUTISPG Image and Signal Processing (3 ECTS)
- IPM-18AUTCVEG 3D Computer Vision (5 ECTS)
- IPM-18AUTIVSEG Introduction to Vehicles and Sensors (4 ECTS)

I&E (6 ECTS)

- IPM-13feszSTG_16 **I&E study** (6 ECTS)

SECOND SEMESTER: Master's thesis (30 ECTS)



EIT Digital

We believe in making and shaping a competitive digital Europe that is inclusive, fair and sustainable and aim at global impact through European innovation fuelled by entrepreneurial talent and digital technology.

We embody the future of innovation by mobilizing a pan-European multi-stakeholder open-innovation ecosystem of top European corporations, SMEs, startups, universities and research institutes, where students, researchers, engineers, business developers and investors address the technology, talent, skills, business and capital needs of digital entrepreneurship.

We build the next generation of digital ventures, digital products and services, and breed digital entrepreneurial talent, helping business We build the next generation of digital ventures, digital products and services, and breed digital entrepreneurial talent, helping business and entrepreneurs to be at the frontier of digital innovation by providing them with technology, talent, and growth support:

For more information, visit www.eitdigital.eu. Follow us on Twitter: @EIT_Digital



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