**This course syllabus is discontinued or replaced by a new course syllabus.**

ÖREBRO UNIVERSITY

**Course Syllabus**

School of Science and Technology

# Computer Science, Research Methodologies for Intelligent Systems, Second Level, 30 Credits

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| **Course Code:** | DT4041 | **Subject Area:** | Field of Technology |
| **Main Field of Study:** | Computer Science | **Credits:** | 30 |
| | | **Subject Group (SCB):** | Computer Science |
| **Education Cycle:** | Second Cycle | **Progression:** | A1N |
| **Established:** | 2011-11-01 | **Last Approved:** | 2018-04-27 |
| **Valid from:** | Autumn semester 2018 | **Approved by:** | Head of School |

## Aims and Objectives

### General aims for second cycle education

Second-cycle courses and study programmes shall involve the acquisition of specialist knowledge, competence and skills in relation to first-cycle courses and study programmes, and in addition to the requirements for first-cycle courses and study programmes shall
- further develop the ability of students to integrate and make autonomous use of their knowledge
- develop the students' ability to deal with complex phenomena, issues and situations, and
- develop the students' potential for professional activities that demand considerable autonomy, or for research and development work.

(Higher Education Act, Chapter 1, Section 9)

### Course Objectives

Knowledge and understanding
After the course the participant should
- be able to account for control schemes commonly used in modern robotic systems,
- be able to discuss control requirements in terms of controllability and stability,
- demonstrate knowledge of the the different types of sensors commonly used on mobile robotic platforms and understanding of the basic principles of operation of different types of sensors, and
- demonstrate understanding of search problems in the field of artificial intelligence: understand how problem structure relates to the formal properties of the problem, and understand the computational bottlenecks of different problem solving algorithms.

Applied knowledge and skills
After the course the participant should be able to
- synthesize and tune control schemes for the robotic application at hand,
- write software for robot applications using modern tools,
- formulate real world problems as search problems, and sketch methods to solve them based on uninformed, heuristic and constraint-based search, and
- configure, calibrate and use modern sensors in the context of mobile robots.

Making judgments and attitudes
After the course the participant should be able to
- make judgments with regards to relevant scientific, societal and ethical aspects, and show awareness of ethical aspects of research and development
- judge the possibilities and limitations of science, its role in society and people's responsibility for how it is being used, and

- reason about limitations and advantages of different sensor types and algorithms for control and artificial intelligence, given an application.

## Main Content of the Course

Sub-course I: Introduction to Robotics and Intelligent Systems, 7.5 credits
- Academic reading and writing
- robot programming and middleware,
- ethics in robotics and its applications,
- probability theory and state estimation,
- fundamentals of computer science from a robotics point of view,
- actuators and sensors, and
- robotics history.

Sub-course II: Sensors and Sensing, 7.5 credits
- The role of sensors in a probabilistic robotic framework,
- positioning sensors: encoders and accelerometers,
- range sensors: sonars, radars and laser range finders,
- image sensors: cameras,
- global positioning sensors: GPS and indoor localization systems,
- 3D range sensors: ToF, structured light and stereo vision,
- chemical sensors,
- calibration,
- noise modelling and characterization, and
- noise filtering and sensor data processing.

Sub-course III: Advanced Artificial Intelligence, 7.5 credits
- Introduction to intelligent agents,
- problem solving and search: uninformed and informed search strategies,
- constraint reasoning, backtracking search, and
- boolean satisfiability, the DPLL algorithm.

Sub-course IV: Robot Modelling and Control, 7.5 credits
- Analysis of linear (and in part of nonlinear) systems,
- stability criteria,
- observability and controllability ,
- common motion control schemes applied to robotic systems (PID control, linearization and decoupling, predictive control, passivity-based control), and
- overview of interaction control schemes (force control, impedance control).

## Teaching Methods

Introduction to Robotics and Intelligent Systems: seminars, lectures and practical exercises.

Sensors and Sensing: lectures and laboratory exercises.

Advanced Artificial Intelligence: lectures.

Robot Modelling and Control: lectures and project assignments.

Students who have been admitted to and registered on a course have the right to receive tuition and/or supervision for the duration of the time period specified for the particular course to which they were accepted (see, the university's admission regulations (in Swedish)). After that, the right to receive tuition and/or supervision expires.

## Examination Methods

*Introduction to Robotics and Intelligent Systems*, 7.5 Credits. (Code: 1000)
Oral and written reporting of literature and lab assignments.

*Sensors, Theory*, 3 Credits. (Code: 3000)
Written exam. A retake will be scheduled to take place within eleven weeks of the regular examination.

*Sensors, Laboratory Work*, 4.5 Credits. (Code: 0310)
Written report of laboratory work.

*Advanced Artificial Intelligence*, 7.5 Credits. (Code: 0700)
Written exam. A retake will be scheduled to take place within eleven weeks of the regular examination.

*Robot Modelling and Control, Theory*, 3 Credits. (Code: 8000)
Written exam. A retake will be scheduled to take place within eleven weeks of the regular examination.

*Robot Modelling and Control, Laboratory Work*, 4.5 Credits. (Code: 9000)
Written reports on project assignments.

For further information, see the university's local examination regulations (in Swedish).

## Grades

According to the Higher Education Ordinance, Chapter 6, Section 18, a grade is to be awarded on the completion of a course, unless otherwise prescribed by the university. The university may prescribe which grading system shall apply. The grade is to be determined by a teacher specifically appointed by the university (an examiner).

According to regulations on grading systems for first- and second-cycle education (vice-chancellor's decision 2010-10-19, reg. no. CF 12-540/2010), one of the following grades is to be used: fail, pass, or pass with distinction. The vice-chancellor or a person appointed by the vice-chancellor may decide on exceptions from this provision for a specific course, if there are special reasons.

Grades used on course are Fail (U), Pass (G) or Pass with Distinction (VG).

*Introduction to Robotics and Intelligent Systems*
Grades used are Fail (U), Pass (G) or Pass with Distinction (VG).

*Sensors, Theory*
Grades used are Fail (U) or Pass (G).

*Sensors, Laboratory Work*
Grades used are Fail (U), Pass (G) or Pass with Distinction (VG).

*Advanced Artificial Intelligence*
Grades used are Fail (U), Pass (G) or Pass with Distinction (VG).

*Robot Modelling and Control, Theory*
Grades used are Fail (U) or Pass (G).

*Robot Modelling and Control, Laboratory Work*
Grades used are Fail (U), Pass (G) or Pass with Distinction (VG).

To receive Pass with Distinction (VG) on the course, it is required to have VG on at least 16,5 credits.
ECTS Grading
The course grading is translated to the ECTS grading scale.

For further information, see the university's local examination regulations (in Swedish).

## Specific entry requirements

The applicant must have a completed Bachelor degree, comparable to a Swedish Bachelor degree, from an institution of higher education of three years or more. The Bachelor degree must include courses in mathematics: calculus, algebra and computer engineering: programming, algorithms and data structures.
If the applicant's first language is not English, knowledge in English must be documented by an internationally recognized proficiency test.

For further information, see the university's admission regulations (in Swedish).

## Transfer of Credits for Previous Studies

Students who have previously completed higher education or other activities are, in accordance with the Higher Education Ordinance, entitled to have these credited towards the current programme, providing that the previous studies or activities meet certain criteria.

For further information, see the university's local credit transfer regulations (in Swedish).

## Other Provisions

The course is given in English.

## Reading List and Other Teaching Materials

**Part 1: Additional Reading**

Bruno Siciliano, Oussama Khatib (eds.) (2008)
*Springer handbook of robotics*
Springer, 1611 pages

Lin, Patrick; Abney, Keith; Bekey, George A. (2012)
*Robot ethics: the ethical and social implications of robotics*
ISBN: 9780262298636

**Part 2: Additional Reading**

de Silva, C. W. (2015)
*Sensors and Actuators: Engineering System Instrumentation, Second Edition*
CRC Press, ISBN: 9781466506817, 847 pages

Stoyanov, T. (2016)
*Sensors and Sensing: Course Notes*
online: http://www.aass.oru.se/Research/mro/courses/sens/notes.pdf

**Part 3: Required Reading**

Russell, Stuart and Norvig, Peter 2010, (Third Edition)
*Artificial Intelligence, A modern Approach Prentice Hall*
Prentice Hall, ISBN: 0136042597, 9780136042594, 1132 pages

**Part 3: Additional Reading**

Dechter, Rina (2003)
*Constraint Processing, The Morgan Kaufmann Series in Artificial Intelligence*
Elsevier Science ISBN 0080502954, 9780080502953, 480 pages

**Part 4: Additional Reading**

F. Lewis, D. M. Dawson and C. T. Abdallah (2003)
*Robot Manipulator Control - Theory and Practice*
CRC Press, , ISBN: 9780824740726, 638 pages

## Additions and Comments on the Reading List

Ytterligare material utdelas under kursens gång.
Additional material is handed out during the course.