CENTER FOR ROBOLUTION

RoboTamers ® Program

RoboTamers Research Program	Research Orientation & Problem Formulation						Research & Development	Maximum Points
	1st	2nd	3rd	4th	5th	6th		2000
Introduction to Scientific Work								100
Advanced Scientific Work								100
Mathematics for Robots & Control								100
Autonomous Mobile Cognitive Robots								100
Agile Development Project Work								200
Research Problem Formulation								300
Publish 5 Research Papers in IEEE Conferences or Journals								300
Inventive, Innovative & Smart Work								200
Proof of Concept for the formulated problem								600

First Milestone – Score 900 Points & Get Earning Opportunities

Second Milestone - Score more than 1600 Points & Get R.A.R.E Job Contract

Introduction to Scientific Work

Prerequisites	Curiosity, systematic thinking, endurance, willingness to work hard.
Learning Targets	• Professional competency: Performing a literature survey. Knowing criteria to distinguish good from weak research papers. Proficiency in using scientific literature databases and using tools for literature and idea management. • Methodological competency: Systematically approach a new (scientific) subject, identify the state of the art in a certain field. Distinguish what has been achieved and where the hard problems and open issues are. Concisely defining the direction of own research. • Individual competency: Doing first steps towards one's own research
Content	- In group work we will address the following issues and questions • What are helpful resources for literature search? • What is a citation index and how to use it? • How to systematically search papers? • How to create a key word structure and identify related topics? • How to create "your own" citation index? • How to sort and classify all the literature which you found? • How to create a bibliography and what styles to use? • How to create an annotated bibliography? • How to read and analyze scientific articles? • What is a good paper and what is a bad one?
Passing Requirements	Annotated, sorted and structured bibliography covering the 30 most relevant papers for a given subject

Advanced Scientific Working

Prerequisites	Curiosity, systematic thinking, endurance, willingness to work hard, Module ISW
Learning Targets	• Professional competency: Knowing structure and style of different kinds of scientific writings. Citation styles and proper handling of references and third party contributions. • Methodological competency: To identify the state of the art in a certain field and the major achievements and contributions. Ability to analyse and evaluate a scientific paper and its scientific contributions and deficits. Identifying the scientific challenges and problems in a field, generating a problem formulation for ones own research. • Individual competency: Ability to work on a scientific subject
Content	In group work we will address issues such as: • how to read and evaluate a paper • how to analyse and present the scientific content of a paper • how to compare several scientific approaches • how to identify the 30 most relevant article in a selected field • how to sort and classify this articles • how to write a state-of-the-art report • how to write a survey article on a selected field, • how to derive from the state of the a problem formulation of own research
Passing Requirements	• Six essays analysing the contributions and deficits of six selected scientific papers. • Annotated bibliography for R&D project. • Problem formulation for R&D project. • Extended abstract for R&D project.

Mathematics for Robots & Control

Prerequisites	Good knowledge in linear algebra and analysis, fluent knowledge in some mathematical scripting language

Learning Targets	• Professional competency: Knowing and understanding modelling principles; knowing and understanding basic problems and requirements for robust control, knowledge and understanding of mathematical concepts behind simulation.
	• Methodological competency:
	  ○ Apply coherent solution principles, be able to structure and abstract.
	  ○ Ability to model / simulate / control typical sample problems in mobile robotics, apply theoretical principles to restricted sample problems.
	  ○ Transfer insights from models to more realistic systems.
	• Individual competency: Strong problem-solving skills using mathematical methods, proficiency in handling of mathematical concepts, notations, and argumentations

Content	Modern design flows for the programming of robotic systems require the modelling and simulation of systems in order to develop stable control and filtering algorithms. This course will lay the necessary foundations in modelling based on primarily linear system theory, then performing numerical simulation based on real world parameterized models and finally development of robust control algorithms.
Passing Requirements	Homework & Project Assignment

Autonomous Mobile Cognitive Robots

Prerequisites	Bachelor level knowledge in mathematics and core-engineering

Learning Targets	• Professional competency:
	  ○ Basic and advanced concepts of robotics and sensorimotor systems, and essential concepts and techniques for mobility, navigation and robot control.
	  ○ Properties and (dis)advantages of different drive systems and sensor, know principles and limits of mapping and path planning algorithms.
	• Methodological competency:
	  ○ Structuring a complex problem like an mobile robot controller architecture into modules and subtasks and model the relationships between system components.
	  ○ Select and implement appropriate methods to tackle common mobile robot tasks.
	  ○ Evaluate and understand the strengths and limits of different mapping, navigation or planning algorithms in a given task scenario.
	  ○ Systematically implement and test a system using modern software engineering techniques.
	• Individual competency:
	  ○ Strong problem-structuring and solving skills, proficiency in analytical (“top-down”) problem decomposition.
	  ○ Efficient team team-oriented software development under tight time constraints

Content	Structure of autonomous mobile robots • Locomotion • Kinematics • Sensors and actuators • Hardware components for mobile robots • Exploration and mapping • Self-localization and SLAM • Path planning and execution • Navigation and obstacle avoidance • Cognition & Artificial Intelligence
Passing Requirements	Homework & Agile Development Project Formulation

Agile Development Project

Prerequisites	1. Ability to develop algorithmic solutions for problems. 2. Good programming abilities in object-oriented languages Java, Python and C++. 3. Ability to use standard software development tools and IDEs like Eclipse.
Learning Targets	Professional competency: • Knowing modern software engineering methods: Description languages to model data, process or control flow aspects of software systems. • Understanding specific challenges of distributed or multi-threaded architectures. • Knowing standard algorithms and data structures for data management (lists, trees, sets etc.) • Understanding usability and accessibility constraints. • Knowledge of libraries, tools, and software patterns relevant for solving advanced programming problems in distributed computing Methodological competency: • Creating and assessing software designs for given application problems. • Analyzing failure modes and error conditions for software systems. • Concise specification of requirements of software systems. • Maintaining complete and accurate software documentation (user documentation as well as implementation documentation). • Ability to apply advanced programming concepts and techniques in general contexts. • Ability to design software for distributed systems. • Ability to apply these concepts to problems in robotics. Individual competency: • Structuring complex problems into its constituents. • Organizing and conducting collaborative work in a team. • Creating detailed specifications from vague problem descriptions. • Ability to get quickly acquainted with large software libraries and new tools. • Ability to test and debug software applying the learned concepts
Content	Agile software team techniques are studied and practiced in the context of developing software for robotics and embedded systems. – object-oriented software design – agile software development, extreme programming – model-driven software development – software patterns – refactoring
Passing Requirements	Group Project Work