ISEL
INSTITUTO SUPERIOR DE ENGENHARIA DE LISBOA

ISEL ADEM
Área Departamental de Engenharia Mecânica

Sheet course ()

Course	MSc IN MECHANICAL ENGINEERING		
Unit	Industrial Robotics	Mandatory	☐
		Optional	☒
Unit scientific area	Control Systems	Category	B

Unit category: B - Basic; C - Core Engineering; E - Specialization; P - Complementary.

Year: 2nd	Semester: 1st		ECTS: 5,0			
Contact time	Total:	T:	TP: 45,0	PL:	S:	OT:

T - Lectures; TP - Theory and practice; PL - Lab Work; S - Seminar; OT - Tutorial Guidance.

Unit Director	**Title**	**Position**
Francisco M. de Oliveira Campos	Ph.D.	Assistant Professor

Learning Objectives (knowledge, skills and competences to be developed by students)

(max. 1000 characters)

The course aims at building skills to support: robot manipulator programming for palletizing tasks; selecting programming structures to address different task scenarios; debugging and optimizing robot control programs; the identification of hardware and software components of robotic systems and diagnosing failures in the main components; analysing and integrating Flexible Manufacturing Systems; designing simple image processing systems for feature extraction; identifying the main problems in mobile robots control and implementing simple strategies to address them.

Syllabus

(max. 1000 characters)

1. ROBOT MANIPULATORS

Introduction- Classification of robot manipulators; sensors and actuators in robot manipulators. Control of Robot Manipulators- Programming languages; control levels; trajectory generation; forward kinematics; introduction to inverse kinematics; Jacobian and task space velocity. Industrial Robots- Specifications of industrial robots; common geometric structures in industrial robots and main applications.

2. FLEXIBLE MANUFACTURING SYSTEMS

Components – product transfer system, automatic storage system, processing stations and quality control system. Control and Monitoring- Control levels in flexible manufacturing systems.

3. ADVANCED TOPICS IN ROBOTICS

Computer Vision- digital image processing: filters; morphologic operations and segmentation; feature extraction. Mobile Robotics- mobile robot configurations; sensors and actuators; movement control and planning strategies.

Demonstration of consistency of the syllabus with the objectives of the course

(max. 1000 characters)

The course contents introduce the necessary concepts to the study and use of robot manipulators, namely those concerned with the components of the system and the representation and control spaces. The fundamental concepts underlying the operation of a Flexible manufacturing system are presented, providing the basis for their analysis and integration. Digital image representation is addressed along with the most common processing operators, allowing for the development of simple feature extraction systems. The problem of mobile robot control is defined and the most common strategies to address it are presented, thus providing the basis for the development and tuning of these controllers.

Teaching methodology (evaluation included)

(max. 1000 characters)

Oral lectures and problem solving in the classes; laboratory exercises in programming a virtual and a real robot; problem solving in the integration of subsystems in a Flexible Manufacturing System; discussion on approaches and results; visual feature extraction resorting to image processing functions with Matlab support; discussion on limitations and possibilities; implementation of a mobile robot controller in a virtual and a real scenario.

The assessment in the course is based on a written examination (test or exam) and a project developed in the laboratory.

Demonstration of consistency of teaching methods with the learning objectives of the course

(max. 3000 characters)

The theoretical concepts concerned with each topic of the course are presented through exposition in the class. Practice in the use of robot manipulators is acquired by programming manipulation tasks in a virtual and a real system. The concepts underlying the operation of a Flexible manufacturing system are exemplified in the lab equipment and the corresponding integration solutions are pointed out. Skills in image processing systems development are acquired through programming exercises in the Matlab environment. Finally, students gain experience in mobile robot control by programming controllers for a virtual model and an existing mobile robot.

Main Bibliography

(max. 1000 characters)

- Klafter, R.D., Chielewski, T. A., Negin. Robotic Engineering – An Integrated Approach. M. Prentice-Hall, 1989.
- Pires, J. Norberto. Automação Industrial. Lidel, 2002.
- Campos, F. Course Handouts.
- Image Processing Toolbox User´s Guide. Mathworks..