UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	ELECTRONICS ENGINEERING
SUBJECT	INDUSTRIAL ROBOTICS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20925-Attività formative affini o integrative
CODE	20510
SCIENTIFIC SECTOR(S)	ING-INF/04
HEAD PROFESSOR(S)	D'IPPOLITO FILIPPO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	102
COURSE ACTIVITY (Hrs)	48
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	INDUSTRIAL ROBOTICS - Corso: CYBER-PHYSICAL SYSTEMS ENGINEERING FOR INDUSTRY INDUSTRIAL ROBOTICS - Corso: INGEGNERIA DEI SISTEMI CIBER-FISICI PER L'INDUSTRIA
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**D'IPPOLITO FILIPPO** Monday 15:30 17:30 Piattaforma MS-TEAMS codice n0hly57 Wednesda 9:00 10:00 Edificio 10

DOCENTE: Prof. FILIPPO D'IPPOLITO

PREREQUISITES	Mathematics courses (both basic and higher-level courses), Fundamentals of Mechanical Engineering
LEARNING OUTCOMES	EXPECTED LEARNING RESULTS Knowledge and understanding: • At the end of the course, the student will be familiar with the issues related to the kinematics, the dynamics and the modalities of control of industrial robots. Ability to apply knowledge and understanding • The student will be able to make the right choice of both robot structure and programming in relation to the specific needs of the flexible working cell. Autonomy of judgment: • The student will be able to interpret the correct mode of operation of the choice made in relation to the application. Communication skills: • The student will acquire the ability to communicate and express problems related to the subject of the course. She will be able to support conversations on topics related to robot applications in the flexible industry. Learning Capacity: • The student will have consolidated many of the mathematics, analytical geometry and rational mechanics knowledge, and this will allow him to continue engineering studies with greater autonomy and discernment.
ASSESSMENT METHODS	Written test to ensure the ability to associate a suitable kinematic and dynamic model with a serial kinematic structure; Matlab programming test of some functions of industrial robot, Jacobian, direct and inverse kinematic, direct and inverse dynamics, motion planning. The final evaluation starts from the 18/30 grade, awarded when the objectives achieved are at least elementary, up to the 30/30 cum laude, as the objectives are achieved in an excellent manner. The same applies to non-attending students.
EDUCATIONAL OBJECTIVES	The course aims at providing the basic knowledge necessary to write in a systematic way the kinematic equation and the equations of motion (dynamic model) of a spatial mechanism (robots). The knowledge acquired in the course makes it possible to write general-purpose programs that simulate the kinematic and/or dynamic behavior of machines, to develop algorithms for motion control of automatic machines and/or manipulators and, eventually, to read the literature of the field.
TEACHING METHODS	Theoretical lectures / exercises. During the course, in addition to the lectures, the implementation in the MATLAB environment of some of the algorithms presented during lectures are required with a short report.
SUGGESTED BIBLIOGRAPHY	•Dispense e slide fornite dal Docente, in lingua inglese/Handouts and slides provided by the Teacher, in English •L. Sciavicco, B. Siciliano, L. Villani, G. Oriolo, Robotica, McGraw-Hill, 3 a edizione, 2008, ISBN 978-8838663222 •L. Sciavicco, B. Siciliano, L. Villani, G. Oriolo, Robotics: Model Planning and Control, Springer, ISBN 978-1846286414

SYLLABUS

Hrs	Frontal teaching
10	Introduction; Kinematics; rotation Matrix; rotation Matrix composition; euler angles; angle axis representation; Homogeneous tranformation Matrix; direct kinematics; kinematics of typical structure; Joint space and opeartional space; kinematica calibration; inverse kinematics;
10	differential kinematics; geometric Jacobian Matrix; Jacobian Matrix for typical manipulators; kinematical singularities; redundancy; differential kinematics inversion; analitical Jacobian Matrix; kinematical inversion Matrix;
7	Dynamics; Lagrange formula; model properties; identification of dynamical parameters; direct and inverse dynamics; operational space dynamical model; dynamic manipulability ellipsoid;
4	trajectory planning; joint space trajectory; cartesian space rajectory;
5	motion control; independent joint space motion control; PD control law with gravity compensation; computed torque control law; adaptive control
2	sensors and actuators

Hrs	Practice
4	Direct and inverse kinematics
4	Differential kinematics; Differential kinematics inversion and redundancy
4	Robot manipulator dynamic model; dynamic model of the SCARA AMADEUS2 robot

Hrs	Workshops
4	Experimental exercise on the robots available in the Motion Control and Industrial Robotics laboratory (COMAU SMART SIX, anthropomorphic and AMADEUS II, scara) of the Engineering Department, ed.10