Óbuda University Bánki Donát Faculty of Mechanical and Safety Engineering		Insitute of Mechatronics and Vehicle Engineering	
Subject title and code:	**Industrial Robots Kinematics and Dynamics BMXRRE5BNE**		**Credits:** *7*
Full-time study	*ac. year*	*2023/24 semester I*	
The course is available at:	mechatronical engineering		
Supervised by:	Dr. József K. Tar	**Instructors:**	Dr. József K. Tar
Prerequisite (neptun code):	Mechanics III. BGMNE3NNE		

Weekly number of lessons			
Lecture: 2	Group seminar: 0	Lab: 2	Consultation:

Way of assessment:	Exam (Oral)
Online consultation *(in case it's required):*	*https://bbb2.banki.hu/b/tar-vpt-qr3 (BBB link)*
Educational goal:	*Description and solution of the forward and inverse kinematic task of robots of open kinematic chain with a redundant general arm structure. Introducing students to basic movement control methods based on the dynamic model. The purpose of the exercises is to introduce effective simulation and documentation methods.*

Schedule

Education week	**Topics**
1.	Operations that can be performed with rigid bodies: rotations around the origin as linear operations, scalar product, definition of rotation matrices; the operation of rigid translation.
2.	Rotations around the origin and subsequent translation: homogeneous coordinates and homogeneous marices.
3.	Parameters of the rotational operations: the rotation and homogeneous matrices as hypersurfaces embedded in a higher dimensional space; the identity operator, the tangent space of the hypersurface at the identity element, exponential functions as constant directional displacements in the hypersurface. Deduction ofb the elements of the tangent space
4.	Transformed tangents. The tangent space at the identity element as a linear spcae and an algebra. Selection of right handed system of basis vectors in the tangent space. The rotational aixs and the angle of rotation. The Rodrigues formula. Calculation of the parameters of the Rodrigues formula from the rotational matrix. Rotated rotational axis
5.	Cartesian Workshop Frame of coordinates. the „home position". The forward kinematic task
6.	The translational and totational velocity at the tool center point. Setting the differential inverse kinematic task.
7.	Optimization under constraints. The Newton-Raphson Method. Gradient6 Descent Method. Reduced Gradient and Lagrange Multipliers The Moore-Penrose pszeudoinverse.
8.	Basics in Julia language.: integer and floating point representation of numbers. Arrays and operations with arrays; global and local variables and their use in functions and for-next cycles. Function declaration. Making figures by the use of the PyPlot package. Matplotlib. The LATEX as object-oriented text editor. Document cClasses, embedded components, labels and rferences. Citation by the use of BIBTEX databases. The TexStudio as excellent aid for using LATEX.
9.	Solution of the inverse kinematic task for redundant open kinematic chain.
10.	Equations of motion of the robot with trespect to an inertial system of reference: deduction of the equations of motion from the dynamic model. Euler-Lagrange equations of motion, generalized coordinates, generalized forces. as torque or force components. Theoretical possibility for setting the dynamic model by the use of homogeneous coordinates.
11.	The Computed Torque Robot Control Possible requirements for making the trajectory tracking error converge toward zero: exponential-polynomial forms, Lyapunov equation, PD- or PID type controller The effects of the errors in the dynamic model ont he precision of trajectory tracking.

12.	The Robust Variable Structure/Sliding Mode Controller.
13.	Analysis and use of various dynamic models for the simulation of control tasks.
14.	End of semester consultation.

Mid-semester requirements

Test		Assignment to be submitted		Lab measurement	
amount	dates	amount	deadlines	amount	dates
[--]	--	1 piece of complex task	The last day of the education	[--]	--

According to the Study and Examination regulations of Óbuda University attendance of group seminars and lab exercises are mandatory.

Other requirements for participation in sessions not covered by the regulations and restrictions on substitutions:

Test		Assignment to be submitted		Lab measurement	
maximum points available	minimum score required to pass /test	maximum points available	minimum score required to pass / assignment	maximum points available	minimum score required to pass /lab
…points	…points	…points	…points	…points	…points

Total number of points achievable in semester: …points				
Grading thresholds	**satisfactory** … choose	**average** … choose	**good** … choose	**excellent** … choose

Other evaluation criteria:

Receive a signature denied entry:

Required references: Lecture notes in PDF and sample programs available during the semester

Recommended references: Somló J., Lantos B.,P.T. Cat, Advanced Robot Control. Akadémiai Kiadó, Budapest 1997

Quality assurance methods of the subject: **There is possibility for online consultationj with the teacher on request in the necessary extent.**

Things, that are not included, can be found within the regulations of Óbuda University.