# Examination Questions for the Final Exam Industrial Robot Kinematics and Dynamics (BMXRRE5BNE) (for January 2021, refreshed: 14 October 2021)

1. The concept of „Group" and "Lie Group";

2. Generators of Lie Groups, exponential series of constant generators, "transformed generators", Lie algebra, the geometric interpretation of the Lie brackets (commutators), Jacobi identity;

3. Basis vectors in the tangent space at the identity element, structure coefficients, commutation relationships;

4. Homogeneous matrices as Lie groups: their generators and the physical interpretation of the generators;

5. Parametrization of Lie groups with special emphasis on the Orthogonal Group and the group of the Homogeneous Matrices; The Right Hand convention;

6. Formulation of the forward and inverse kinematic task for the robots of open kinematic chain: home position and kinematic parameters, redundancy, differential formulation of the inverse kinematic task;

7. Optimization under constraints, the Lagrange multipliers and the reduced gradient method, the Moore-Penrose pseudoinverse;

8. Kinematic singularities; Tackling the problem of sinularities by “deforming” the Moore-Penrose pseudoinverse;

9. The basics of Classical Mechanics: space and time, inertial systems of reference, Newton's Postulates;

10. The Variation Principle in Classical Mechanics: generalized coordinates, the Lagrangian, the Euler-Lagrange equations for isolated systems (the set over which the optimizatio happens; the quantity that is optimized);

11. The Euler-Lagrange Equations for not isolated system: the generalized forces;

12. Industrial robots of open kinematic chain, the application of homogeneous matrices for setting the dynamic model of the robot; the main limitations of this model;

13. The „Computed Torque Control": the general form of the dynamic model; PID and PD-type feedbak coefficients, feedback coefficients designed on the basis of the Lyapunov equation; Special PID and PD type feedback gains determined by a single $\Lambda$ parameter.

14. The Robust Sliding Mode /Variable Structure Robust Controller: error metrics, relative order of the system under control, chattering and its elimination; PD and PID-type solutions.