Robot Control - Theory Exam - 2024/25

Write your student ID and name on every sheet of paper. You can use a calculator and a ruler. You have 20 minutes to solve the problems.

Problem 1 (7 points)

A mass-spring system is subject to damping and a nonlinear restoring force, modeled by the equation:

$$\ddot{z} + 2\beta\dot{z} + \alpha z - \gamma z^3 = 0$$

where: $z(t)$ is the displacement, $\beta = 0.5$ is the damping coefficient, $\alpha = 1$ is the linear stiffness coefficient, $\gamma = 1$ is a nonlinear coefficient.

1. (4 points) Linearize the system around the fixed points.
2. (1 point) Perform two simulation steps using the Forward Euler method and a timestep $\Delta t = 0.1$ starting at the fixed points.
3. (1 points) Perform one simulation steps using the Forward Euler method and a timestep $\Delta t = 0.1$ when initial conditions are $z = 1$ and $\dot{z} = 1$.
4. (1 point) Discuss the results. Will the system stay at the fixed points during the simulation? Why yes or why not? Does the result depend on the choice of the timestep? How the behaviour at the fixed points compares to any other initial state?