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Autonomous robotics

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Exercise 1 Dynamical Systems Tutorial

1. Solve the linear differential equation

$$\tau \dot{x} = -x$$

analytically. (If unfamiliar, get help from a text book or online resource.)

2. Plot the solution as a function of time by setting $\tau = 5$ seconds, using a few discrete times, $t = 0, 1, 2, ...10$ seconds and evaluating the function numerically on the computer in a program of your choice. Make this plot for two values of the initial condition, $x(0)$.

3. Compute from the analytical solution the time, Δt, in which $x(t)$ has fallen to $1/e$, that is, determine Δt such that

$$x(t + \Delta t) = x(t)/e$$

Does this time depend on $x(0)$?

4. Plot the dynamics of task (1) and designate the fixed point. Make the same drawing for a dynamics with the same slope and fixedd point $x_0 = 1$. Write down the equation for that dynamics.

5. Now consider this nonlinear differential equation

$$\tau \dot{x} = x - x^3$$

Compute its fixed points and plot the function using the same numerical procedure of task (2). Mark the fixed points in the plot and state if they are attractors or repellors.