Course „Control Systems 2“

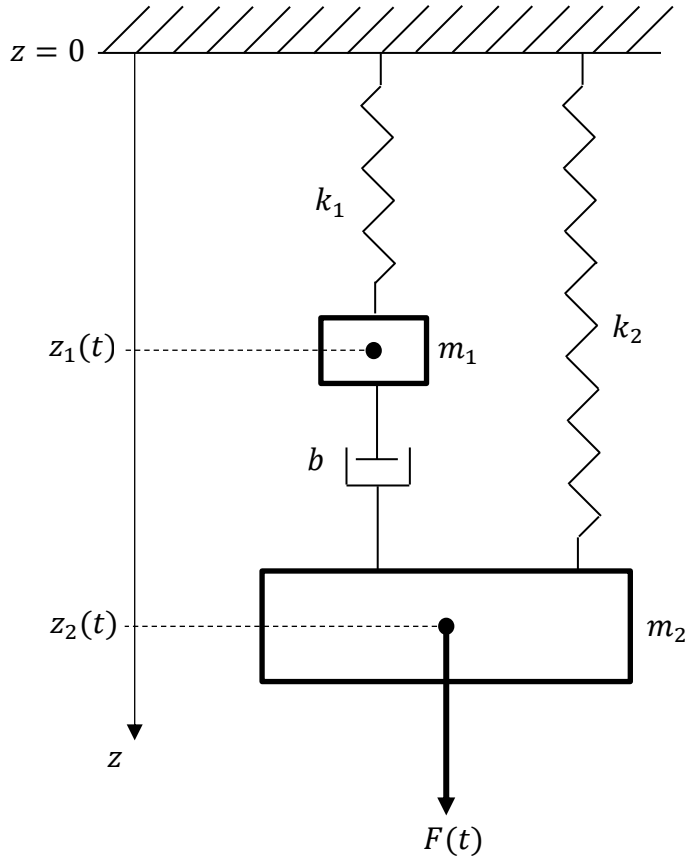
Exercise Sheet 2

Task 2:

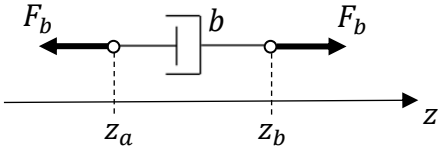
Consider the two-mass system (masses m_1 and m_2) shown in the figure below with two linear springs (spring constants k_1 and k_2) as well as one viscous damper with damping coefficient b. Assume that the springs are forceless at the positions $z_1(t) = z_{10} > 0$ and $z_2(t) = z_{20} > z_{10}$, respectively. Moreover, the force $u(t) = F(t)$ shall be the only input and the speed of the second mass the only output of the system, i.e. $y(t) = \dot{z}_2(t)$. Gravity is <u>not</u> considered.

a) Find a state space description of the system.

b) Are the resulting state equations linear and/or time-invariant? Why (not)?



<u>Hint</u>: A viscous damper generates a force which is proportional to the speed difference at its ports. Moreover, the force is always directed such that the movement is slowed down (see sketch below).



$$F_b = b(\dot{z}_a - \dot{z}_b)$$