Linear control system design SSY285

Assignment $M2$

Analysis of linear state-space model of a DC-motor with flywheel

Pre-approval of solution is mandatory before submission from TA (tutorial session)

Problem

Consider the DC-motor with flywheel, that was in focus in the previous assignment $M1$. Starting point of this assignment is the linear state-space model from the previous assignment $M1$, questions (b, c). Use the same numerical values when required as in assignment $M1$ d).

Questions

a) Investigate if the system is controllable and observable for nonzero, positive and finite parameter values of the motor resistance R. Use the same parameter notation as it was introduced in assignment $M1$. (**Hint:** Use D_1 as a symbolic variable while calculating controllability/observibilty matrix and then later substitute $D_1 = 20$ to avoid numerical errors in Matlab.)

b) If the system is not controllable or observable, is it still stabilizable or detectable for nonzero, positive and finite parameter values of the motor resistance R?

c) Given the numerical parameter values from assignment $M1$, repeat the above tasks by using of standard Matlab routines. Check the condition number of the controllability and observability matrices, before you conclude the analytic properties.

d) Choose the value $T_s = 1\,millisecond$ as the sampling interval and calculate the discrete time system matrix $A_d = e^{A_c T_s}$. (Here A_c denotes the corresponding continuous time parameter matrix.)

e) Using the same sampling interval as above, calculate the discrete time input matrix with ZOH principle, given by the expression $B_d = \int_0^{T_s} e^{A_c t} B_c dt$.

f) Check (numerically) if the resulting discrete time state-space model is minimal order and if its eigenvalues are in the region of stability!

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