Homework #3

May 2, 2007

Problem 1: Investigate stability of the origin by using center manifold theorem for the systems in the Exercises 8.6 (2) and 8.8 for all possible values of parameter $a \in \mathbb{R}$.

Problem 2: Solve the Exercises 10.12 and 10.13.

Problem 3: The output $y = x_1$ of the system

$$\begin{aligned} \dot{x}_1 &= x_2 \\ \dot{x}_2 &= u \\ \dot{\eta} &= \eta + x_1 + c x_2^2, \; c \in \mathbb{R}, \end{aligned}$$

is to asymptotically track a reference signal $y_d(t) = M \sin(at + \phi)$, where $a > 0$ is a known constant and $M, \phi > 0$ are unknown constants.

1. Construct an exosystem to model the reference signals in the above class.
2. Solve the *state feedback regulator problem* (SFRP) for the above system and $c = 1$. (Hint: The component of the center manifold corresponding to the zero dynamics state is a quadratic polynomial.)
3. Consider the following two error signals: a) $e_1 \triangleq x_1 - y_d(t)$, and b) $e_2 \triangleq x_1 + \frac{1}{2}\eta - y_d(t)$. Which of the corresponding *error feedback regulator problems* (EFRP) is solvable for the above system and $c = 0$? Design a regulator which solves the EFRP for that case.
4. Simulate the closed-loop trajectories of the above system in the EFRP for $a = 1$. Assume that the nominal value of the parameter a is $\hat{a} = 1$, while its actual value is $a^\star = 1.05$. Repeat the simulation and comment.

The homework is due on next **Wednesday, May 9**. If you have technical questions, my email is **dragan.dacic@gmail.com**.