EE6415: Nonlinear Systems Analysis

Jan-May, 2022

Assignment 7(Bonus)

Instructions :

- **Submit on or before 11:59 PM, 24/04/2022**
- You have to turn in the well-documented code along with a detailed report of the results of the experiments. The code must be in a separate file(which can be directly run in matlab), and not a part of the report.
- Any kind of plagiarism will be dealt with severely. Acknowledge any and every resource used, including any coursemates you may have discussed with.
- Include any plots/images you deem necessary
- Your submission must be named "RollNo.pdf". For example, if your roll number is EE17B158, your submission must have the name "EE17B158.pdf".
- Your submissions must be made on moodle. Any emailed submissions will not be accepted.
- It is required that you use LaTeX for writing your report. A template has been provided along with this assignment for the same.

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1. Consider the nonlinear system:

$$\begin{aligned}
\dot{x}_1 &= x_2 \\
\dot{x}_2 &= cos(x_3) + x_1 + u \\
\dot{x}_3 &= x_4 \\
\dot{x}_4 &= x_1 + u \\
y &= x_1
\end{aligned}$$

   Find the relative degree of the system and convert it to the normal form. Design a feedback linearization control law for this system. Is the system stable? Plot relevant phase portraits/state trajectories to justify your answer.

2. Design a sliding-mode controller for the system given below, to track $x_d(t) = sin(t)$

$$\ddot{x} + a(t)\dot{x}^2 cos(5x) = b(t)u$$

   Where $1 \leq a(t) \leq 2$ and $4 \leq b(t) \leq 8$. Introduce a boundary layer to remove chattering. Plot $s(t)$, $\dot{x}(t)\ vs\ x(t)$ and $u(t)$.