

Quiz 2

General Instructions

1. The choice questions to be answered is as follows:
 - (a) Students, whose roll numbers ending with '4', please answer (a), (d), (g), and (j) parts of each questions, if they are available.
 - (b) Students, whose roll numbers ending with '7', please answer (b), (e), (h), and (k) parts of each questions, if they are available.
 - (c) Others, please answer (c), (f), (i), and (l) parts of each questions, if they are available.
2. Provide mathematical expressions wherever necessary.
3. Please do not copy from others.
4. Make sure you have sufficient time to convert the answers into PDF and make the submission.

Questions

1. Consider the following sliding variables (filtered tracking error) and develop sliding mode controllers (filtered tracking error based controller) for the Euler-Lagrangian system, $M\ddot{q} + H = \tau$, where M is the invertible mass matrix, q is the generalised position, e equals $q - q_{des}$, and τ is the control input. State the conditions for stability in each case, where $r =$:
 - (a) q
 - (b) $-q$
 - (c) $q + \dot{q}$
 - (d) e
 - (e) $e + \dot{e}$
 - (f) $e + \dot{e} + \int e dt$
2. Consider the following functions, where q and e are the same as the previous question for the same EL system. State and prove why or why not they can be used as Lyapunov functions. Can they be used for specific conditions?
 - (a) q
 - (b) $-q$
 - (c) q^2
 - (d) e^2
 - (e) \dot{e}^2
 - (f) $\dot{e}^2 + e^2$
 - (g) $(\dot{e} + e)^2$
 - (h) $\sin^2(e + \dot{e})$
 - (i) $\cos^2(e + \dot{e})$
 - (j) $\log(e + \dot{e})$
 - (k) $\log((e + \dot{e})^2)$

- (1) $\log(1/(1 - (e + \dot{e})^2))$
- 3.
 - (a) What is chattering and how can it be reduced?
 - (b) What are the disadvantages of high gain controller?
 - (c) State Barbalat's lemma.