Homework 2

Question 3: Control of dynamic systemsa. Control of a second order dynamic system

Consider the dynamic system defined as,

$$\ddot{x} + 5\dot{x} - 4x = u$$

Assume that you start from $x = 0$, $\dot{x} = 0$ and $u = 0$.

- Express the dynamics of the system in state space form and compute the eigen values of the system dynamics matrix. What can you say about the stability properties of the system.
- Compute the controllability matrix of the state-space equation you obtained.
- Using $u = 0$, numerically solve the the system dynamics equation to verify your predictions (use ode45).
- Use pole-placement technique to compute the gain matrix such that the eigen values of the modified system are at -2 and -3.
- Use this control law to achieve a desired set point given by $x = 4$. What can you say about the control thus generated? Is this control signal feasible?
- Use this control law to track a time-dependent signal given by $x(t) = \sin(2t)$. What can you say about the control thus generated? Is this control signal feasible?
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- Modify your controller to add an additional state, the integral of the error between current and desired state.
- Use pole-placement technique to compute the gain matrix such that the eigen values of the modified system are at -2,-3 and -4.
- Use this control law to achieve a desired set point given by $x = 4$. What can you say about the control thus generated? Is this control signal feasible?
- Use this control law to track a time-dependent signal given by $x(t) = \sin(2t)$. What can you say about the control thus generated? Is this control signal feasible?
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- Modify your controller to add an additional state, the integral of the error between current and desired state, and include first order actuator dynamics given by $\dot{u} = -5(u - u_c)$.
- Use pole-placement technique to compute the gain matrix such that the eigen values of the modified system are at -2,-3,-4 and -5.
- Use this control law to achieve a desired set point given by $x = 4$. What can you say about the control thus generated? Is this control signal feasible?
- Use this control law to track a time-dependent signal given by $x(t) = \sin(2t)$. What can you say about the control thus generated? Is this control signal feasible?

Compare the controllers from parts a,b and c, and make a recommendation of which controller you will choose and why?