Please do your assignment independently.

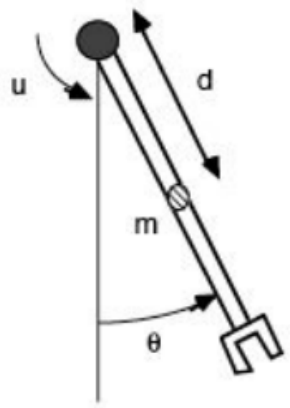
Problem 1

Consider a one-link robot arm with true model

$$I\ddot{\theta} + mgd\sin\theta + f_v\dot{\theta} = u$$

(with friction)
And the model estimate is

$$\bar{I}\ddot{\theta} + \bar{m}g\bar{d}\sin\theta + \bar{f}_v\dot{\theta} = u$$



- Write the system model in the linear form of $Y(\theta, \dot{\theta}, \ddot{\theta})\alpha$ where α is the parameter vector.
- Derive the passivity-based adaptive controller.
- Given the real dynamic coefficients

  $$I = 7.5,\ mgd = 6;\ f_v = 1.5$$

  and initial estimate

  $$\bar{I} = 8, \bar{m}g\bar{d} = 5, \bar{f}_v = 2.5$$

  Design the adaptive controller for trajectory tracking, where the desried trajectory is $\theta_d(t) = -\sin t$. Plot the following figures in your report:

  - The state trajectory and the desired state trajectory over time.
  - The input trajectory over time.
  - The errors in parameters over time.