MAE 282
ADAPTIVE CONTROL Prof. M. Krstic

Homework 3

Consider the levitated ball problem from Section 8.3 in the [KKK] book.

1. Specialize the reduced-order observer-based adaptive control law (8.296), (8.300), (8.302) with (8.289), (8.290) to the case where the current $x_3 = I$ is directly controlled.

2. Develop a *detailed* Lyapunov stability analysis using the Lyapunov function (8.306) with $z_3 = \tilde{\varrho}_3 = \tilde{\theta}_2 = 0$.

3. Perform the closed-loop simulations of the adaptive controller from Problem 1.

4. Compare the performance of the controller from Problem 3 to the performance of the PD controller

$$I(t) = I_0 + K_{\rm p}(y(t) - y_{\rm r}) + \frac{K_{\rm d}s}{\varepsilon s + 1}[y(t)]\,, \qquad 0 < \varepsilon \ll 1 \tag{1}$$

Note that the ideal value of the setpoint current is $I_0 = \sqrt{\frac{Mg}{\lambda(y_{\rm r})}}$, namely, it depends on both the setpoint position $y_{\rm r}$ and, unfortunately, on the unknown mass $M = 1/\theta_1$ of the ball. Your comparison should reflect the fact that M is unknown and it should involve several different values for $y_{\rm r}$.