ENME808B: APPLIED NONLINEAR CONTROLS

Homework #08

(Due November 5, 2018)

1. [Example 7.2] Consider the nonlinear system

$$\ddot{x} + a(t)\dot{x}^2 \cos 3x = u$$

where $1 \leq a(t) \leq 2$. The desired trajectory is given by $x_d(t) = \sin\left(\frac{\pi}{2}t\right)$.

1) Verify that if the BL width and sliding surface BW is chosen by $\Phi = 0.1$ and $\lambda = 20$, the switching sliding control law is designed as follows:

$$u = \hat{u} - k\,\text{sgn}(s) = 1.5\dot{x}^2 \cos 3x + \ddot{x}_d - 20\dot{\tilde{x}} - (0.5\dot{x}^2|\cos 3x| + 0.1)\text{sgn}(\dot{\tilde{x}} + 20\tilde{x})$$

2) Verify that for the same choice of BL width and sliding surface BW the interpolated sliding control law is designed as follows:

$$u = \hat{u} - k\,\text{sat}\left(\frac{s}{\Phi}\right) = 1.5\dot{x}^2 \cos 3x + \ddot{x}_d - 20\dot{\tilde{x}} - (0.5\dot{x}^2|\cos 3x| + 0.1)\text{sat}\left(\frac{\dot{\tilde{x}} + 20\tilde{x}}{0.1}\right)$$

3) Simulate the above control laws and show the plots for control input and tracking error with respect to time. The plots must essentially look like Figure 7.7 and 7.8.