1. Consider the system
   \[ \dot{x}_1 = \sin x_2 + \sqrt{t + 1}x_2 \]
   \[ \dot{x}_2 = \alpha_1(t) + x_1^4 \cos x_2 + \alpha_2 u \]

   Design the control law \( u \) in order to track the desired function for state \( x_1 \) given by \( x_{d1} \). The functions \( \alpha_1(t) \) and \( \alpha_2(t) \) are unknown but bounded by \( |\alpha_1(t)| \leq 10 \) and \( 1 \leq \alpha_2(t) \leq 2 \). (10 points)

2. Problem 14.31

3. Problem 14.37

4. Consider the system
   \[ \dot{x} = f(x) + a + bu \]

   The function \( f(x) \) is unknown and is estimated by \( \hat{f}(x) \) such that
   \[ \left| f(x) - \hat{f}(x) \right| \leq F(x) \]. The parameter \( a \) is unknown but is either a constant or slowly time varying. The parameter \( b \) is known. Define \( \tilde{x} = x - x_d \), where subscript \( d \) indicated the desired variable, and \( \tilde{a} = a - a_* \), where the subscript * indicates the actual value. Choose the sliding variable as \( s = \tilde{x} \) and a candidate Lyapunov function as
   \[ v = \frac{s^2}{2} + k \frac{\tilde{a}^2}{2} \]. Design an adaptive control law for the system. Show that \( L_{t \to \infty} \tilde{x} \to 0 \). (Show any extra assumptions that were needed to come to this conclusion). (10 points)