CHEM-E7190/2022: Exercise - Linearization Extra

1. Two interacting tank in series with outlet flowrate being function of the square root of tank height are presented in following modeling equations. Linearize the system.

$$\frac{dh_1(t)}{dt} = \frac{F(t)}{A_1} - \frac{R_1}{A_1}\sqrt{h_1(t) - h_2(t)} = f_1(h_1, h_2, F)$$
$$\frac{h_2(t)}{dt} = \frac{R_1}{A_2}\sqrt{h_1(t) - h_2(t)} - \frac{R_2}{A_2}\sqrt{h_2} = f_2(h_1, h_2, F)$$

   Assume only the second tank height is measured.

2. Consider the previous solution. Two interacting tank in series with outlet flowrate being function of the square root of tank height

   Parameter values

   - Parameter values
   $$R_1 = 2.5\frac{\mathrm{m}^{2.5}}{\mathrm{min}}, R_2 = \frac{5}{\sqrt{6}}, \frac{\mathrm{m}^{2.5}}{\mathrm{min}}, A_1 = 5\mathrm{m}^2, A_2 = 10\mathrm{m}^2$$
   - Input variable $F = 5\mathrm{ft}^3/\mathrm{min}$
   - Steady-state height values: $h_{1s} = 10$, $h_{2s} = 6$

   Perform the following simulation using state-space model

   - What are the responses of tank height if the initial heights are $h_1(0) = 12m$ and $h_2(0) = 7m$

3. Linearize the following differential equation:

$$\ddot{y} = 2y + y^2\dot{y} + \dot{y}u - 8$$