Homework Eleven

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1 - A High performance helicopter has a model shown in Figure 1. The goal is to control the pitch angle θ of the helicopter by adjusting the rotor thrust δ. The equations of motion of the helicopter are

$$\frac{d^2\theta}{dt^2} = -\sigma_1 \frac{d\theta}{dt} - \alpha \frac{dx}{dt} + n\delta \tag{1}$$

$$\frac{d^2x}{dt^2} = g\theta - \alpha_2 \frac{d\theta}{dx} - \sigma_2 \frac{dx}{dt} + g\delta \tag{2}$$

Where x is teh translation in the horizontal direction. FOr a miltary high-preformance helicopter we find: $\sigma_1 = 0.415$, $\sigma_2 = 0.0198$, $\alpha_1 = 0.0111$,$\alpha_2 = 1.43$, $n = 6.27$, $g = 9.8$ **all in appropriate SI units. Find:**

(a) A state variable representation of this system

(b) The transfer function representation for $\frac{\theta(s)}{\delta(s)}$

(c) Use state variable feedback to achieve adaquate performances for the controlled system. Desired specifications include:

(1) A steady-state for an input step command for $\theta_d(s)$, the desired pitch angle, less than 20% of the input step magnitude

(2) An overshoot for a step input command is less than 20%

(3) a settling (with a 2% criterion) time for a step command of less than 1.5 seconds

(d) If the state variable is not available, design the observer and control law to meet the design specifications included in part (c)

Final Answer: