CONCORDIA UNIVERSITY

Linear Systems

ENGR 613/2 & ENGR 471/2

Project #1

Consider the inverted pendulum system shown below. Assume that M=2kg, m=0.5kg, l=1m. Define the state variables as $x_1 = \theta$, $x_2 = \dot{\theta}$, $x_3 = x$, $x_4 = \dot{x}$, and output variable as $y_1 = \theta$, $y_2 = x$. Derive the state-space equations for this system.

Assuming that we use a state-feedback control $u = -KX$, design a stable control system. For the desired closed-loop poles, consider the following two cases:

Case 1: $\mu_1 = -1.3 + j$, $\mu_2 = -1.3 - j$, $\mu_3 = -20$, $\mu_4 = -20$

Case 2: $\mu_1 = -2$, $\mu_2 = -2$, $\mu_3 = -10$, $\mu_4 = -10$

Determine the state-feedback gain matrix K for both cases. Also, obtain the response of the designed system to the initial condition [$\theta(0) = 0$ rad, $\dot{\theta}(0) = 0, x(0) = 0$, and $\dot{x}(0) = 0$]. Compare the responses of the two systems. (using SIMULINK)