A picture containing fireworks, dark, water, flying

Description automatically generated

College of Engineering

School of Aeronautics and Astronautics

AAE 36401 Lab

Control Systems Lab

Lab 3 Pre-Lab

The Control of the Inverted Pendulum

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The gains using Pole Placement:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| -47.9001 | 67.5785 | -29.6405 | 9.5819 |

The gains using LQR:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| -18.7083 | 74.5253 | -26.4867 | 9.5819 |

The poles for Pole Placement:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| -3+3.5i | -3-3.5i | -10 | -15 |

A close up of a piece of paper

Description automatically generated

The poles for LQR:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| -46.4366 | -3.1942+1.7633i | -3.1942-1.7633i | -2.0139 |

A screenshot of a cell phone

Description automatically generated

The Xc for the pole placement and LQR is plotted as below

A close up of text on a white surface

Description automatically generated

The pendulum angle alpha for the pole placement and LQR is plotted as below

A picture containing text

Description automatically generated

MATLAB CODE

% AAE364L pre-lab3

% Tomoki Koike

clear all; close all; clc;

set(groot, 'defaulttextinterpreter','latex');

set(groot, 'defaultAxesTickLabelInterpreter','latex');

set(groot, 'defaultLegendInterpreter','latex');

setup\_lab\_ip01\_2\_sip;

% Get the poles and plot them

% Pole Placement

lambda1 = -3+3.5i;

lambda2 = conj(lambda1);

lambda3 = -10;

lambda4 = -15;

lambdas\_pp = [lambda1, lambda2, lambda3, lambda4];

K\_pp = place(A, B, lambdas\_pp)

K = K\_pp;

sim('s\_sip\_lqr.mdl')

% LQR - Linear Quadratic Regulator

diagonal = diag([35, 35, 0, 2]);

K\_lqr = lqr(A, B, diagonal, 1/100)

K = K\_lqr;

lambdas\_lqr = eig(A-B\*K\_lqr);

sim('s\_sip\_lqr.mdl')

% Plotting

fig0 = figure();

plot(real(lambdas\_pp), imag(lambdas\_pp), 'b.', 'MarkerSize', 18)

title('Poles for Pole Placement - T. Koike')

xlabel('real')

ylabel('imaginary')

hold on

plot(linspace(-60,10,2^6), 0\*linspace(-60,10,2^6),'--k')

plot(0\*linspace(-30,40,2^6), linspace(-30,40,2^6),'--k')

hold off

grid on; grid minor; box on;

xlim([-60, 10]); ylim([-30, 40]);

fig1 = figure();

plot(real(lambdas\_lqr), imag(lambdas\_lqr), 'r.', 'MarkerSize', 18)

title('Poles for LQR - T. Koike')

xlabel('real')

ylabel('imaginary')

hold on

plot(linspace(-60,10,2^6), 0\*linspace(-60,10,2^6),'--k')

plot(0\*linspace(-30,40,2^6), linspace(-30,40,2^6),'--k')

hold off

grid on; grid minor; box on;

xlim([-60, 10]); ylim([-30, 40]);

saveas(fig0, 'labP\_pole\_pp.png');

saveas(fig1, 'labP\_pole\_lqr.png');