

## MODELING AND CONTROL OF MECHATRONIC SYSTEMS

## Lab III : Position Controller Design Guide

This document describes the design of a position control system for the position control laboratory experiment carried out at the position control rig in L204 of the School of Mechanical and Manufacturing Engineering. The control software is already operational on the control computer. The students are expected to bring along the controller coefficients to be entered into the program. The software is written by Mr. Jim Sanderson and conforms to the block diagram shown in Fig. 1(a). This block diagram can be simplified to obtain that shown in Fig. 1(b). The control design follows the Direct Analytical Design method to design the internal velocity feedback loop and then root-locus method to design the external position feedback loop. The design specifications are:

- A speed control time constant of  $\tau$  ms.
- A sampling frequency of  $f_s$  Hz.
- Zero steady state errors in both velocity and position loops.
- Critically damped position controller response.

## 1 Speed Controller Design

The system transfer function is obtained by finding a first order approximation to the open loop data. This is shown in Fig. 2. The equation of the fitted curve is,

$$y(t) = xxxxx(1 - e^{-t/0.xxx})$$

Note that the response corresponds to an applied voltage of 24 volts. Hence the transfer function that relates the applied voltage to the input shaft position is,

$$G'_p(s) = \frac{xxxxx/24.0}{s(1 + 0.xxxs)}$$

Hence, the transfer function relating the input voltage to the input shaft speed in rad is,

$$G_p(s) = \frac{xxxxx/xx}{s(1 + 0.xxxs)} \frac{2\pi}{8192}$$

Hence,

$$G_p(s) = \frac{x.xxxx}{s(1 + 0.xxxs)}$$

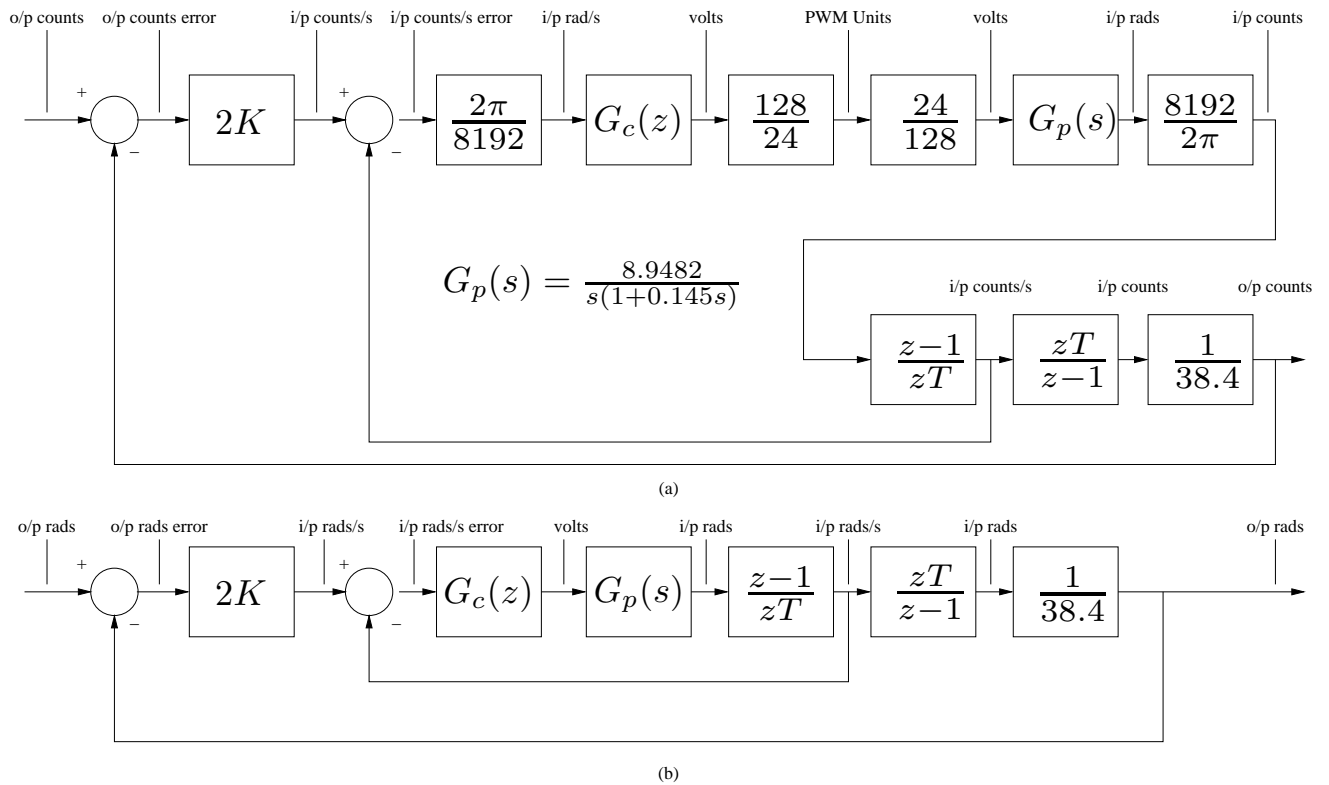


Figure 1: (a) Program implementation, (b) Simplified block diagram

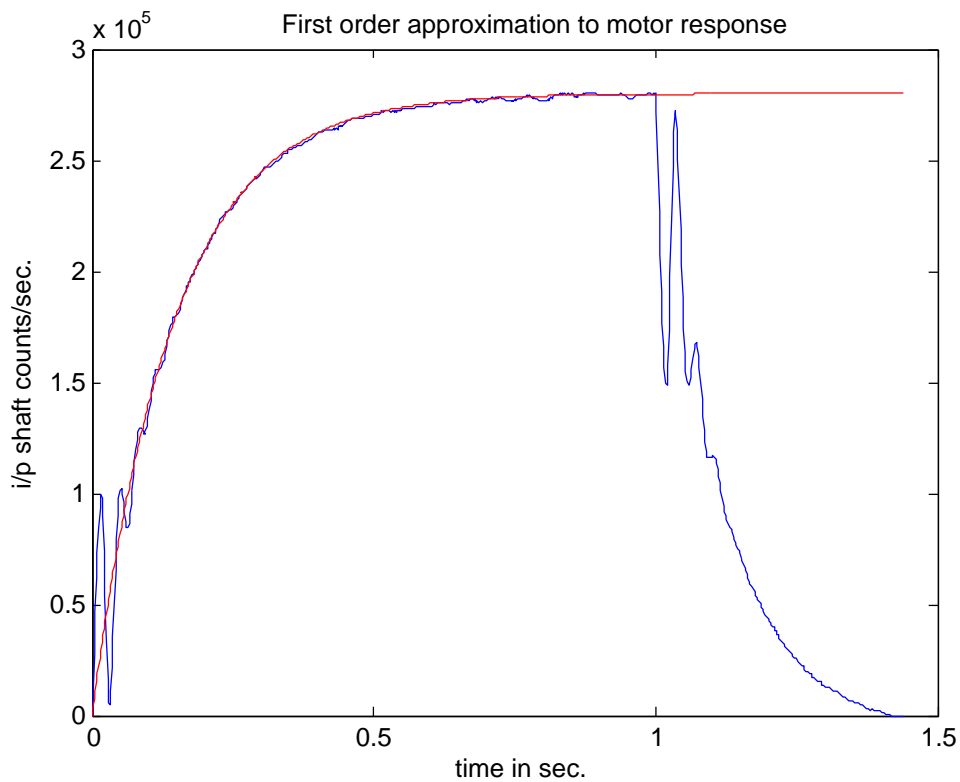


Figure 2: First order curve fitted to motor speed data

