LAB 5 – VELOCITY CONTROL OF A DC BRUSHED MOTOR

University of New Hampshire

30. November 2017

Jesse Feng  
Simon Popecki  
Reilly Webb

******

***VELOCITY CONTROL OF A BRUSHED DC MOTOR***

|  |  |
| --- | --- |
| **Course Number and Name:**  ME 747 – Senior Lab | |
| **Semester and Year:**  2017 semester 2 | **Name of Lab Instructor:**  **Alireza Ebadi** |
| **Lab Section and Meeting Time:**  2b 14:00 | **Report Type:**  **External Group Report** |
| **Title of Experiment:**  **Velocity Control of a DC Brush Motor** | |
| **Date Experiment Performed:**  14. November 2017 | **Date Report Submitted:**  1 December 2017 |
| **Names of Group Members:**  Jesse Feng Simon Popecki Reilly Webb | **Grader's Comments:** |
| **Grade:** |

# Cover Letter

Jesse Feng  
Simon Popecki  
Reilly Webb  
33 Academic Way  
Durham, NH 03824

Alireza Ebadi  
33 Academic Way  
Durham, NH, 03824

Dr. Ebadi,

The following document contains an analysis of control systems for a DC brushed motor. DC motors are generally controlled via pulse width modulation and a microprocessor, however for the purpose of demonstration, we controlled DC motors with power op-amp driven proportion control, integral control, and proportional-integral control.

These control systems were compared against each other in terms of functionality- the motor parameters have been determined through experimentation.

The body of this report comprises of the results of inputs to the system and recorded system response.

Best Regards,

Jesse Feng

Simon Popecki

Reilly Webb

# Contents

[Cover Letter 3](#_Toc499912667)

[Contents 4](#_Toc499912668)

[Objectives 5](#_Toc499912669)

[Executive Summary 6](#_Toc499912670)

[Theory and Experimental Methods 7](#_Toc499912671)

[Results and Discussion 8](#_Toc499912672)

# Objectives

The objective of this experiment was to compare different methods of control using a power operational amplifier. Proportional, Integral, and Proportional-Integral control systems controlled a motor under load to be measured by a second motor. The parameters of the motor were calculated, and the system response determined from experimental data. The motor back EMF, open-loop, and closed-loop response were analyzed in particular. Quantitative analysis was performed and interpreted. All relevant values are tabulated/listed. Gain values were confirmed by root locus analysis.

# Executive Summary

In this experiment three types of power op-amp control systems were used to control the speed of a DC brushed motor. Proportional control, Integral control, and Proportional-Integral control systems were used. PID control was not used in this experiment. Motors were controlled by voltage, rather than the conventional method of pulse width modulation. The objective of the control systems was to maintain motor speed regardless of the load placed on the motor. Motor speed was measured by a tachometer.

This experiment assumes that the electrical time constant was much less than the mechanical time constant – so that it may be neglected in the analysis.

The DC motor’s back EMF constant was found to be #. This value was determined by back driving another motor, referred to in this report as the MUT (motor under test). The torque constant Kt was calculated to be # - it was assumed that Kt = Ke. The resulting motor torque value was calculated to be # oz\*in/A. This value matches the specifications provided by the motor manufacturer.

The motor’s open-loop response for a disturbance torque and input voltage step was recorded and analyzed. The time constant and system gain were calculated – a disturbance load was implemented with a switch to measure steady state error – the steady state error is the difference between the motor’s no-load speed and speed under load. The motor time constant was found to be #, and the motor gain value was found to be #. The stall torque of the motor was calculated to be #. The moment of inertia and damping constant of the system were calculated to be # and # respectively.

Closed-loop motor response to a voltage step input and disturbance torque was recorded with a tachometer in the same way as the open-loop response. The power op-amps were controlled by a 741 op-amp – proportional, integral, and proportional-integral control were implemented and analyzed. SHOW SPEEDS OF EACH CONTROL SYSTEM. In a purpose-built closed-loop system the magnitude of each control element (P,I,D) is modified such that it has a larger or smaller role to fit the individual needs of the system. Generic control parameters were used for this experiment (non-optimized).

# Theory and Experimental Methods

# Results and Discussion