

Electromechanics Lab EM3 - Introduction to DC Motors

Mon. 22nd April 2024

L. Albery¹

¹*Mechanical Engineering BEng, University of Sussex*

E-mail: *la463@sussex.ac.uk*

SUMMARY: The experiment examined a DC motor's behavior under varying conditions using variable voltage. Objectives included analyzing speed-voltage relationships and observing speed changes with torque load. Results showed expected proportionalities, confirming theoretical predictions. Specifically, speed was proportional to supply frequency and inversely related to shaft torque. These findings offer insights into electromechanical system dynamics, enhancing understanding of DC motor performance under different loads.

1. INTRODUCTION

This experiment involves testing a DC motor using a variable voltage controller. The setup includes the DC motor, a dynamometer load unit for applying adjustable mechanical loads controlled by a computer, and virtual instrumentation for displaying electrical and mechanical measurements on a computer screen. CassyLab 2 is the software that was used for recording and controlling this experiment.

1.1. Objectives

Here are the objectives laid out by the brief¹:

- (i) To find the relationship between the motor no-load speed and the armature applied voltage.
- (ii) To observe the change in speed with torque load.
- (iii) To find the relationship between the motor armature current and the torque load.

2. RESULTS

The results for the no load speed test DC 1 are displayed in Table 1 and in Fig 1.

The results for the effect of load test DC 2 are displayed in Table 2. This includes Shaft Torque, the variable; the current, and the motor speed. The armature voltage has been set to 200v and has been kept at that for the entire experiment. In Fig 2, the motor speed is shown against shaft torque. In Fig 3, the current is shown against the same shaft torque.

Table 1: DC Test 1: The No-Load Speed Results

Armature Voltage v(a) (V)	Motor speed Nr (/min)
20	190
30	285
40	386
50	485
60	585
70	685
80	790
90	890
100	986
110	1093
120	1192
130	1290
140	1390
150	1497
160	1604
170	1696
180	1802
190	1908
200	2009

3. DISCUSSION

In this section, this report discusses No Load Motor Speed Test Proportionality, the Effect of Load Torque on Motor Speed and the Effect of Load Torque on Fractional Slip.

¹Oner, M. (2020). Experiment EM3. The University of Sussex.

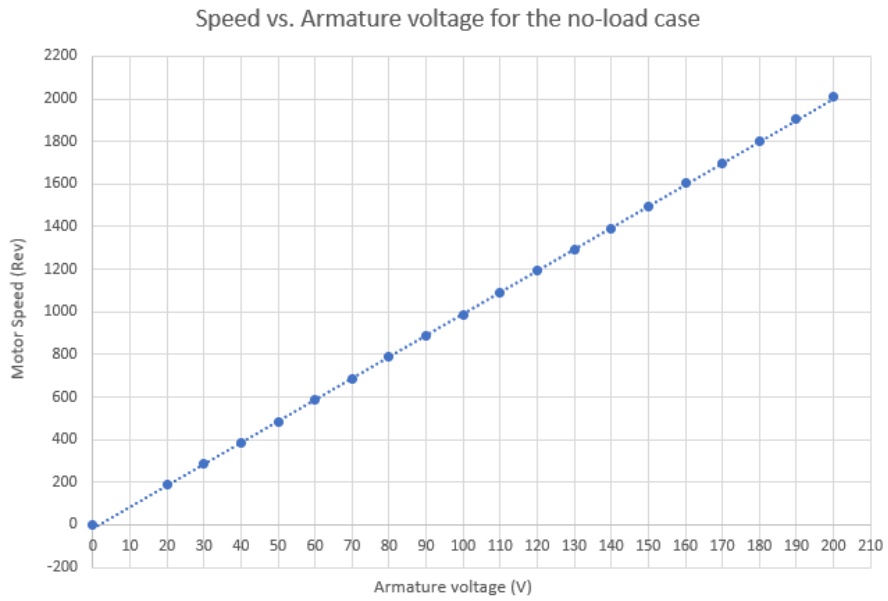


Fig. 1: Motor speed (/min) against Armature Voltage

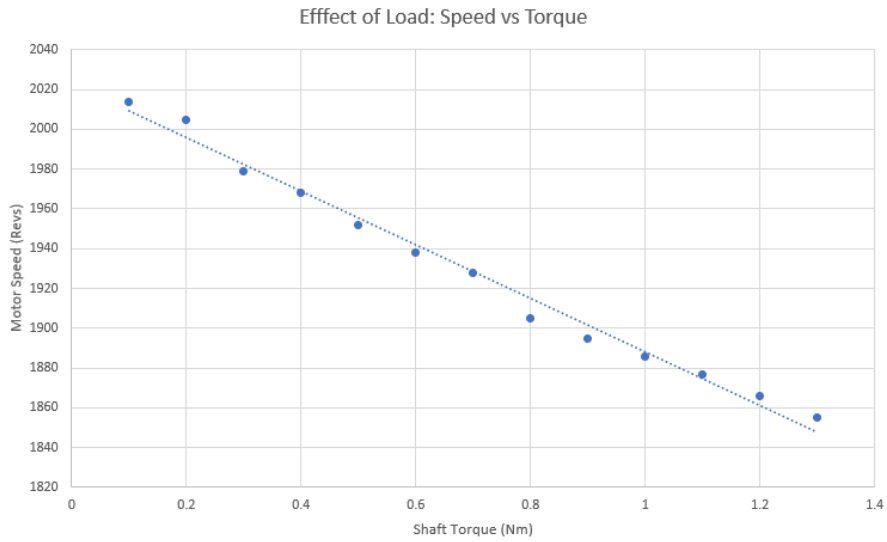


Fig. 2: Motor speed (/min) against Shaft Torque

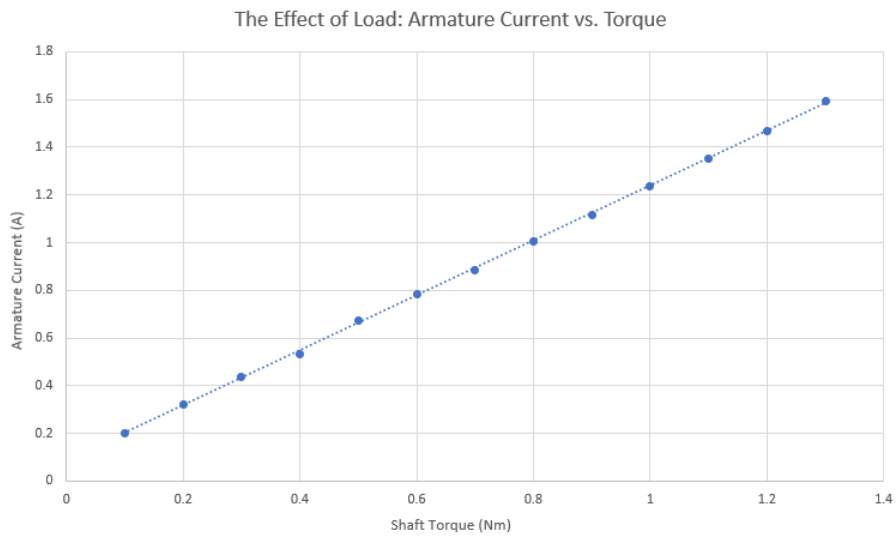


Fig. 3: Current (Amps) against Shaft Torque (Nm)

Table 2: DC Test 3: Effect of Load Results

Shaft Torque (Nm)	Motor Speed (rpm)	Current (Amps)
0.1	2014	0.2
0.2	2005	0.322
0.3	1979	0.436
0.4	1968	0.532
0.5	1952	0.674
0.6	1938	0.784
0.7	1928	0.884
0.8	1905	1.003
0.9	1895	1.115
1	1886	1.237
1.1	1877	1.35
1.2	1866	1.47
1.3	1855	1.596

3.1. No Load Motor Speed Test Proportionality

The line of best fit goes through the origin and is constant which is what is expected. This shows that the motor speed is proportional to supply frequency.

3.2. Effect of Load Torque on Motor Speed

The data, as shown in Fig 2, shows that Motor Speed is inversely proportional to the Shaft Torque.

In other words, as the shaft torque increases, motor speed decreases. This makes sense because the more load, or 'resistive force' the shaft has, the slower the motor will spin around said shaft.

It also makes sense that the line of best fit is first order. When a load is applied to the motor shaft, it

resists the motion of the rotor, thus requiring more torque from the motor to maintain the rotation. As the load torque increases, the motor needs to generate more torque to overcome this resistance. This inverse relationship between torque and speed is often observed in the first-order approximation of the motor's behavior under varying loads.

4. CONCLUSION

This experiment successfully investigated the characteristics of a DC motor using a variable voltage controller. The objectives, including analyzing the relationship between no-load speed and applied voltage, observing speed changes with torque load, and examining the relationship between armature current and torque load, were achieved. The results demonstrated proportionalities expected in motor behavior, with speed proportional to supply frequency and an inverse relationship between motor speed and shaft torque. These findings align with theoretical expectations, confirming the motor's response to varying loads.