

Test of dc shunt motor configuration psychology essay



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Following the experiment conducted on the open frame DC motor configurations, the results gotten from the experiments were explained as follows.

As shown in figure 6. 0, with the motor running at no load, an increase in voltage resulted in an increase in speed and vice versa. This shows that the voltage and speed were proportional to each other. Also with the motor in the no load condition as the voltage increases, the current also increases. The ideal curve for the voltage-speed characteristics of a shunt DC motor follows a linear graph which goes from the origin to the full speed of the motor and voltage. The no load test was also used to determine the back emf constant of the motor. At no load the motor's back emf was dependent on the motor speed and the back emf constant of the motor. The method of calculating the back emf constant from appropriate equations was used and the back emf constant was also determined from the no load test plot of the voltage-speed characteristics. From both methods, the back emf constant correlates with each other with little disparity. This shows that the no load test was an excellent method of determining the back emf constant of the motor.

7. 2 Load test of DC shunt motor configuration

Figure 6. 1 shows the speed-armature current characteristics of the DC shunt motor. In this graph, at a speed of about 2950rpm, the armature current was at a lower value and as the speed of the motor drops due to loading the armature current increases. From the graph it shows that the motor was operational from a speed range of 1400-2950 rpm. The ideal curve follows a sloping curve from no load to full load. In figure 6. 2, the torque-armature <https://assignbuster.com/test-of-dc-shunt-motor-configuration-psychology-essay/>

current characteristics shows that as the motor torque increases, the armature current also increase in a linear way. As seen from the graph, a developed torque of 1. 3Nm resulted in an armature current of 7. 2A which shows the full motor torque and armature current at load conditions were operational at normal operating point. Figure 6. 3 shows that armature voltage control of the speed of the motor was achievable using a variable DC power supply to vary the terminal voltage of the motor. As the voltage was increased, the speed also increases and as the speed decreases, the terminal voltage also decreases since the armature resistance and flux of the motor were constant. In figure 6. 3 and 6. 4, the speed-armature voltage characteristics of the motor were also shown, where the effect of load on the motor during armature voltage control was compared with that during no shaft load. The curve of the speed-armature voltage for load condition was sharper as compared with that of the no shaft load condition. The ideal graph of the speed-armature voltage was a linear graph with positive slope which goes from zero (point of switching) to the point full load but in this case the motor was almost driven to the point where armature reaction was about setting in which give the curved portion of the graph. Hence, the armature voltage control was a good method of speed control if the motor was not operating in the saturated region.

7. 3 Determination of DC Motor parameters

The locked rotor test was used to determine the armature and field resistance. The friction brake was used to lock the rotor of the motor and at that point of locking the torque was noted before the power was switched on. Since the resistance of the windings was dependent on temperature, the test

was quickly conducted so as not to damage the windings of the motor. The test was conducted for different voltage values and the average was taken so that errors introduced during the experiment and the effect of temperature variation on the motor windings can be eliminated. With the armature and field resistance of the motor determined, an AC voltage of lower value was applied across the armature and field windings. The impedance of the windings was recorded and the inductance of the windings was calculated for using the impedance method.

The mechanical parameters of the motor was also determined in which the no load test was used to determine the back emf constant of the motor as shown in figure 6. 5. The slope of the graph gives the back emf constant, since this constant was dependent on voltage and speed in radian per second at steady state. As shown in table 5, the back emf constant was also calculated by taking measurement at no load conditions and calculating the average value of the back emf constant for the resultant voltage and speed. Both methods gave a close value of the back emf constant. The retardation test was used to determine the inertia constant of the motor. In this test, the motor was made to run at no load and load conditions where the results of this experiment were recorded when the power to the motor was cut off. The calculation method proposed by Girirajkumar et al., (2011) to determine the inertia constant and the viscous frictional coefficient (damping factor) was used showing that this method was excellent at determining the inertia and damping factor when the manufacturers information on the motor was unknown. The torque-current characteristic of the motor at load condition was used to determine the torque constant of the motor. The slope of the

graph gave the torque constant since the torque constant equals to the torque divided by the current at steady state. In most cases the torque constant and the back emf constant were assumed to be the same if there are no losses, but in this case the friction brake used to load the motor would generate heat due to losses as such the values of these constants were not the same. The drum of the brake was filled with water to reduce the losses due to friction and extension of the spring contact.

7.4 Open frame DC series motor configuration test

According to Fitzgerald et al., (2003), an increment in load results in armature current increasing provided no saturation. The table of test results for the series configuration was shown in appendix(). Since the series motor has a high starting torque, the motor was loaded at 30V before the applied voltage was finally increased to 50V. From Figure 6.7, as the torque of the motor increases, the speed reduces due to increase in flux, since the armature current and flux were proportional to each other. Also, as the torque goes to zero the speed tends to approach a larger value as shown in the graph. At no load of 0.1Nm, the resulting speed was very high given a value of 4100rpm (no load) and at load of 1.2Nm, the speed became very slow resulting in a speed of 300rpm.

The ideal graph of the speed-torque characteristics of a DC series motor has a sudden drooping nature (Fitzgerald et. al., 2003). From figure 6.8, the armature current started increasing from 0.9A at no load to a maximum value of 4.6A at a full load of 1.2Nm, which shows that the torque was dependent on the armature current. The torque and armature current are proportional to each other and an increase in armature current would result

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in an increase in torque when the load increases and with a reduced load, the armature current reduces resulting in a reduced torque. Therefore the DC series motor should be operated between speeds range of 300rpm to 4100rpm with the mechanical load varied from 0 to 2Nm.

7.5 DC shunt motor test using the 75 turns/1.00mm field windings

According to Stephen and Dale, (2009) the field coils of a series motor has a low resistance consisting of few turns of large diameter coils of wire while the field coils of the shunt motor has a high resistance made up of small diameter coils of wire with many turns. The effect of increase number of turns occurs in a strong magnetic field generation. As shown in figure 6.9, at 2.4A the resulting speed was 1980rpm while at 2.8A the speed was 1700rpm. The shape of the curve was slightly different from the ideal characteristic which was a negatively sloping linear graph. The effect of magnetic hysteresis and armature reaction can be seen from the curve as the motor saturates and these factors contributed to the speed-armature current characteristics of the DC shunt motor deviating from its ideal graph. Figure 6.10 shows the torque-armature characteristics of the motor where the effect of hysteresis and armature reaction occurred when the motor entered into saturation and these effect made the ideal curve (positive slope increasing linearly) to be unattainable in this case.

7.6 Simulation result of the DC shunt motor model in PSpice

Following the model of the DC shunt motor created in PSpice using the schematic editor and the text editor, the models were simulated using the <https://assignbuster.com/test-of-dc-shunt-motor-configuration-psychology-essay/>

DC analysis and transient response of the model. The speed-torque characteristic of the motor was plotted as shown in figure 6. 11. The speed at 470V (470rads⁻¹) resulted in a torque of 0A (0Nm), and as the load increases, the speed reduces while the torque increases. A torque of 1. 4A (1. 4Nm) resulted in a reduced speed of 250V (250rads⁻¹). As shown for the armature current-torque characteristics in figure 6. 12, the armature current increases with an increase in mechanical load which resulted in an increase in torque since the torque was dependent on the armature current and torque constant. Both graphs when compared to the actual motor characteristics, gave the same results showing that the model was developed with accuracy. The transient response of the motor characteristics with respect to time was shown in figure 6. 13 to 6. 14. The torque of the motor as shown by the green plot, shows that the torque rose from 0 to 3. 8A for a duration of 0-0. 4s, before becoming constant from 0. 4s to 2. 0s, the torque was constant. The armature current also rose from 0A to 16A for a duration of 0-0. 4s, and from 0. 4s to 2s the armature current was constant. In figure 6. 14, the speed-time response of the curve shows that at switching the speed of the motor gradually rose and with load being applied, the speed reduces. From 0-0. 4s, the speed went from 0V-1. 8mV and then became constant through the remaining time duration.

7. 7 Gantt Chart

The breakdown of the project technical tasks was created using a Gantt chart before the commencement of the project with start and finished dates allocated to it based on the expected completion date. The Gantt chart was review thrice as the project progressed with some tasks being changed from

sequential task to parallel task while others that could not be achieved within the estimated time were changed. Factors that contributed to the review and amendment to the Gantt chart included issues resulting from the time to determine the motor parameters, ordering of enamelled copper wire and design of new coils. Therefore, the parameters needed to model the open frame DC motor were determined quickly with more accuracy. Some of the coils made were tested so that the performance of the motor could be predicted and estimated. Currently, all the technical tasks in the Gantt chart have been completed entirely. With the technical work scheduled for the project completed, the scheduled Gantt chart was closed at the estimated time.

8 Conclusion

In this project work, a PSpice model of the open frame DC motor was developed. New coils for the motor were designed and tested. The parameters of the open frame DC motor were determined through series of experimental test being carried out on the motor and the determined parameters were used to create a model of the motor. The developed model of the motor was compared to the actual open frame DC motor in terms of the characteristics of the motor in terms of speed, torque, armature current and load conditions. From the test conducted on the actual motor and the model, it was seen that the PSpice model and actual motor agreed showed similarity in the characteristic behaviour.

The speed control of the motor was determined using the armature voltage control method and the designed field coils were used in the DC shunt motor configuration to predict the behaviour of the motor. It was seen that in the <https://assignbuster.com/test-of-dc-shunt-motor-configuration-psychology-essay/>

winding design the effect of air gap, armature reaction and hysteresis could affect the performance of the motor under different conditions of operation. Analysis of the transient response of the PSpice model of the motor under time varying conditions was realized showing that the load conditions affect the motor.

The use of model helps in observing and testing the behaviour of devices when designs are made in industries. The use of mathematical equation such as differential equations to model the behaviour of the open frame DC motor using PSpice was presented. The equivalent circuit of the motor was considered the best method of creating model of the motor because the electrical and mechanical parts of the motor were represented using differential equations.

The project work centred on the development of a PSpice model of the open frame DC motor which introduces the method of determining the parameters of the motor, measuring its characteristics, creation of the model of the motor in PSpice and comparing the accuracy of the motor with the developed model.

9 Future Work

In this project, only the 75turns/1.0mm field coils were tested to predict the performance of the open frame DC motor. It was seen that when the effect of armature reaction, hysteresis and air gap had a great impact on the behaviour of the motor during load conditions. The shape of the speed-torque characteristics and the armature current-torque characteristics can be changed by using the manufacturer's specification in terms of windings

designs and the use of special winding device to allow for uniformity in the layers of the windings being laid. The other field winding coils made should also be tested to establish its effect on the motor.

The use of Matlab/Simulink should also be used to model the open frame DC motor and the results compared with the PSpice model being made so as to appreciate the model developed. The speed control of the motor could also be carried out using all other methods.