

Design and Performance Analysis of PMDC and BLDC Motor using ANSYS Software

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Abstract

This paper connected how to design and simulate of simple PMDC Motor usage ANSYS Maxwell Software. The demand for electrical energy in cars is ascent steady. Permanent Direct Current motor is used for the radiator fan, windshield wipers and washers and to drive blowers for heaters and air conditioners, etc., having brushes which have poor efficiency. It is based on ANSYS Maxwell software which is divided into circuit modeling and field, magnetic circuit calculation of basic dimensions and stator slot design winding design, performance and loss calculation and also using RMXPERT and 2D analysis.

Keywords: BLDC Motor, PMDC Motor, Ansys software, Maxwell Rmxpert

INTRODUCTION

Electrical energy request in car is ascent hurriedly mainly in comfort vehicles because of recent electrical system which robust the comfort and safety of passengers. 48V system is suggested rather than 12V system by many reports and papers. Use of radiator system in cars comes from needfulness of refrigeration IC engine [1].

A DC motor in simple is converts direct current (electrical power) into mechanical energy. It is current carrying conductor placed inside a magnetic field, hence mechanical force developed by conductor. When permanent magnet used to create magnetic field in DC motor [2].

PMDC are best solutions to control of motion and power transmission application where hard size, brad operation speed range, potence to adapt to a range of power sources or the safety considerations of low voltage are effect.

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INDUSTRIAL REVENCE

- This innovative paper was implemented the human errors.
- Industries like have implemented this idea in their factory to achieve good accuracy and to avoid monotonous job of worker hence utilizing them for more useful work.

It develops and markets engineering simulation software. Ansys software is used to design products and semiconductors, as well as to create simulations that test a product's durability, temperature distribution, fluid movements, and electromagnetic properties [3].

Table 1 present comparison between conventional PMDC motor and PMBLDC Motor.

Table 1. Comparison between conventional PMDC motor and PMBLDC Motor.

Features	Conventional DC Motor	PMBLDC Motor
Maintenance	High	Low
Commutation method	Mechanical contact between brushes and commutator.	Electronic switching using power semiconductor devices ie, transistor, MOSFET
Detecting method	Automatically detected by brushes	Rotor position can be detected by using sensor ie, Hall sensor, optical sensor
Controllable	Speed controllable is difficult	Speed can be easily controllable, so that it is possible to have very high speed

MOTOR DESIGN

- Let's focus on this section creation of motor in RMXPERT of ANSYS Maxwell software.
- RMXPERT of ANSYS is based on stencil consonant tool.
- This mechanic and utilization to boost architecture.
- The RMXPERT, Maxwell and made to order equipment for connecting the indispensable of market like minimum cost, light weight, greater efficiency etc. Due to usage the diagnostic instrument theory and magnetic circuit system, RMXPERT evaluate executions of the machine, its conclusion of size and accomplish May diagnostic rapidly [4].
- The RMXPERT promote digest total project by usage the geometry of two dimension, three dimension, equipment, and theory of stimulation circuit for electromagnetic momentary diagnostic. It represents all the accomplish features as current, torque, voltage, speed etc. This method not existing before to architecture the machine by addition of magnetic circuit used to evaluate diagnostic [5].

PMDC AND PMBL DC MOTOR PARAMETER

Design Parameters of machine is shown in Figure 1.

Machine			
	Name	Value	Unit
	Machine Type	Brushless Permanent Magnet DC Motor	
	Number of Poles	16	
	Rotor Position	Inner Rotor	
	Frictional Loss	10	W
	Windage Loss	20	W
	Reference Speed	500	rpm
	Control Type	DC	
	Circuit Type	Y3	

Figure 1. Machine Fixed input parameter.

STATOR DESIGN

- Outer diameter of stator: outer radius of stator is explained as the maximal mileage amid the nucleus of the motor and outer circumference of stator. Stator outer diameter is equal to the double of the radius [6].
- Inner diameter of stator: inner radius of the stator is explained as the maximal mileage amid the nucleus of the motor and inner circumference of the stator. Stator inner diameter is equal to the double of the radius [6]. A motor stator is shown in Figure 2.

ROTOR DESIGN

- Outer diameter of rotor: outer radius of rotor is explained as the maximal mileage amid the nucleus of the runabout and the outer perimeter of the rotor. The outer diameter of the rotor is equal to the double of radius.
- Inside diameter of rotor: Inside radius of rotor is explained as the maximal mileage amid the nucleus of the motor and inner circumference of the rotor. The inner diameter of the rotor is equal to the double of radius. A motor rotor is shown in Figure 3.
 - a. Lodestone (Magnet) density: density is explained as the most mileage during midway site of surface of loadstone and midway point of the top of the lodestone.
 - b. Slot depth: It is explained as most mileage during end point of slot teeth and midpoint of the start point. A schematic representation of slot depth is shown in Figure 4.

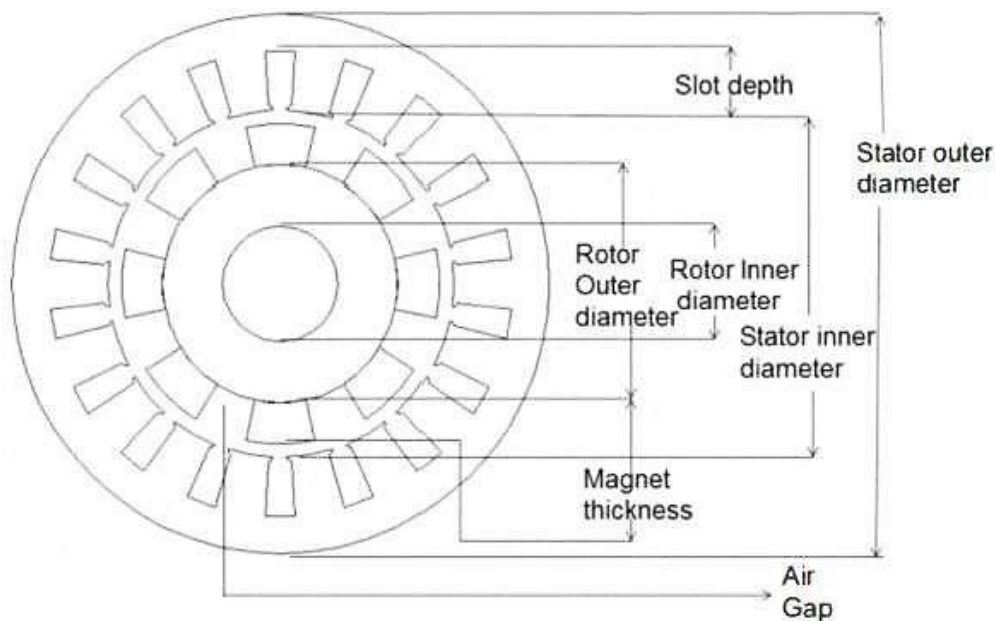


Figure 2. Motor stator.

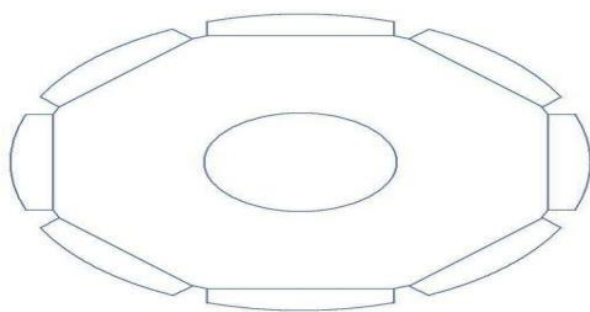


Figure 3. Motor rotor.

DESIGN STEPS OF ANSYS MAXWELL

- Following are the plane use for creation of PMSM in Ansys Maxwell software.
- First of all open the ansys software, as shown in Figure 5.

CHOICE OF MOTOR

Since selection the choice the project file recognize on wooden plank, by Dexter click, you can other name the project name. the right (Dexter) click to the project name and recognize, many types of machine like dc machine, induction motor, generic rotating machine, BLDC motor etc. as shown in Figure 6 [7, 8, 9].

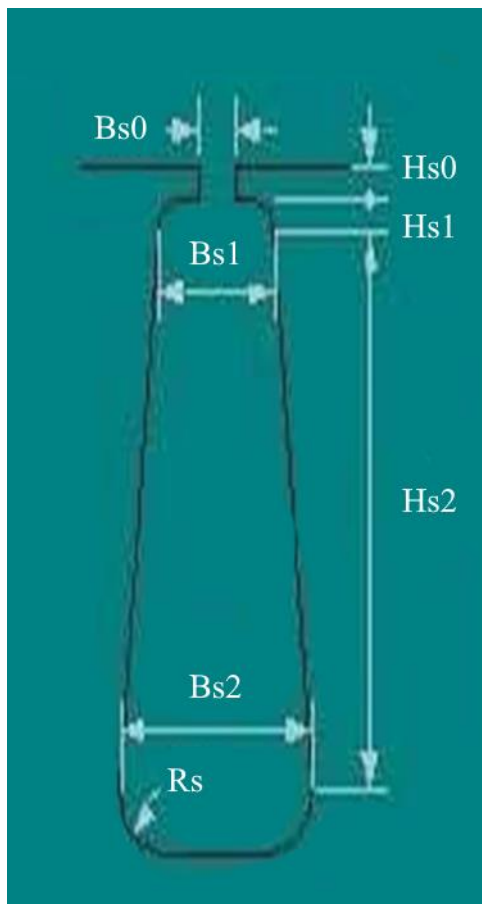


Figure 4. Slot depth.

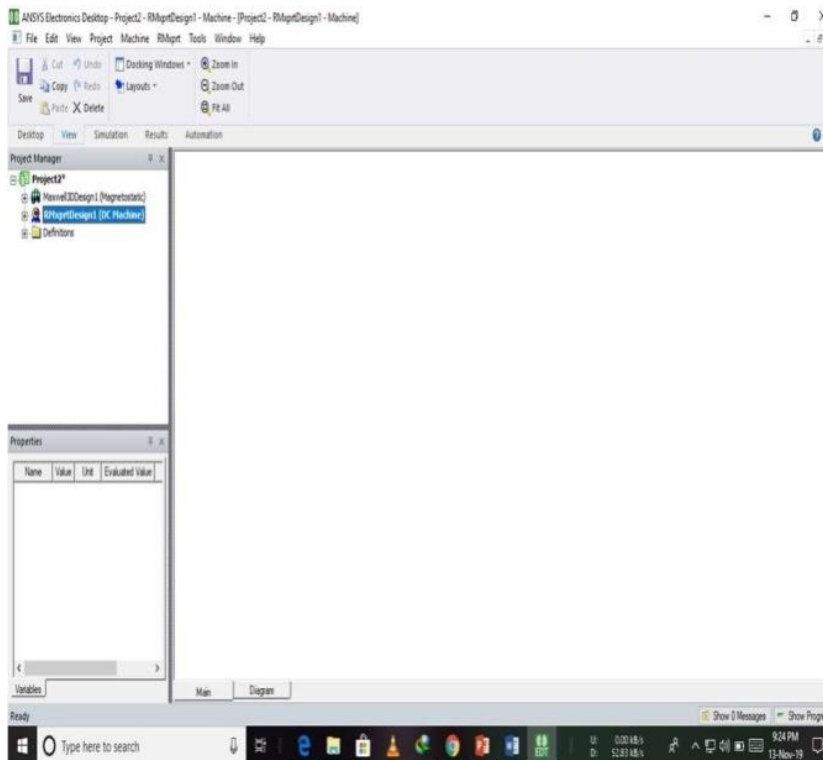


Figure 5. Ansys software first page.

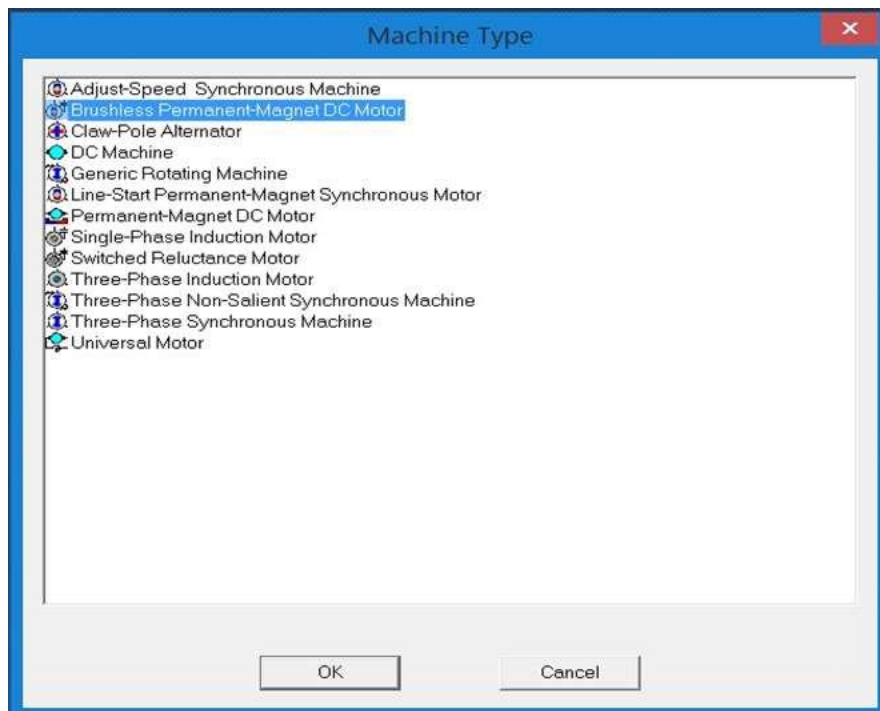


Figure 6. Selection of motor.

CHOICE OF PARAMETER

After choosing the type of machine, machine cage are recognize below project name, enhance the machine cage [8, 9], you occur the cage like rotor (pole, shaft), stator (slot, winding), analysis, resulted as shown in Figure 7.

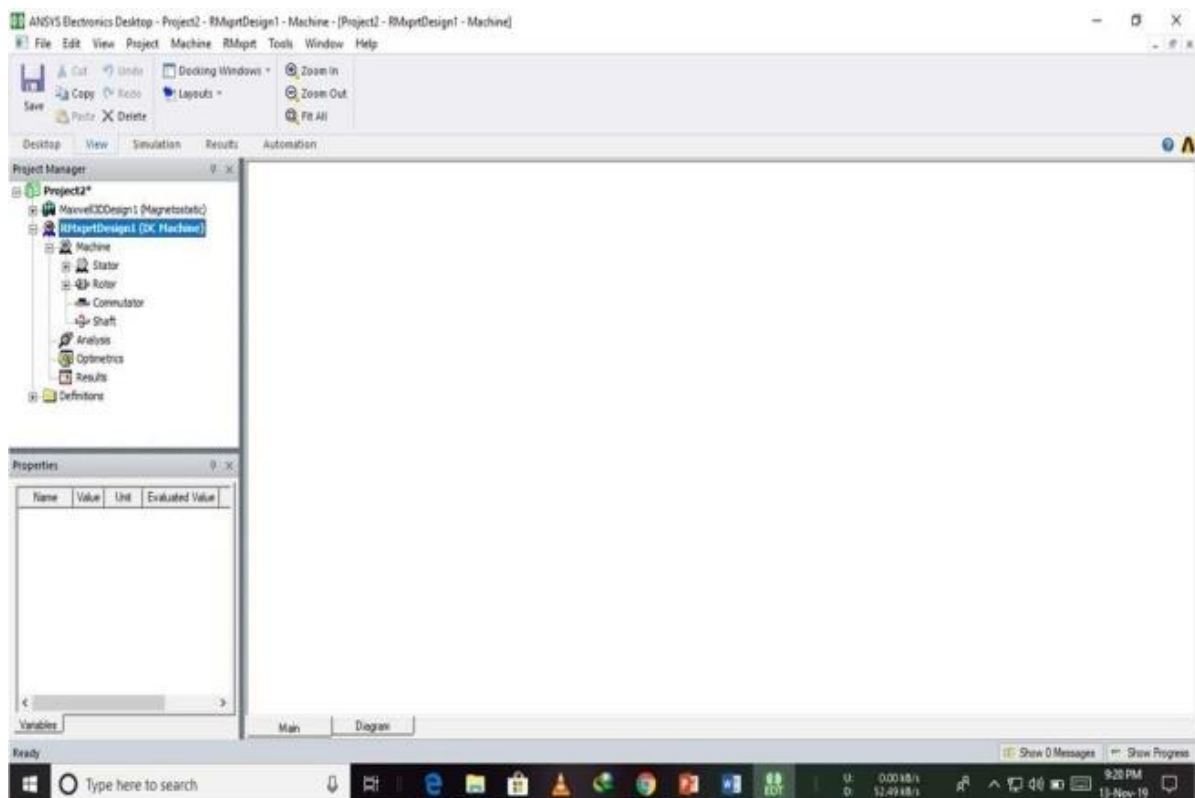


Figure 7. Choice of parameter.

CHOICE OF STATOR

Tape the Stator cage and enhance, so you will occur two cage like slot, windings etc. By clicking every cage, you occur the window two space the input parameter [10, 11]. Give the related value in the table. As shown in Figures 8–11.

Stator

Name	Value	Unit
Outer Diameter	210	mm
Inner Diameter	110	mm
Length	50	mm
Stacking Factor	0.95	
Steel Type	steel_1010	
Number of Slots	30	
Slot Type	4	
Skew Width	1	

Figure 8. Input Stator parameter.

Circuit

Name	Value	Unit
Lead Angle of Trigger	0	deg
Trigger Pulse Width	120	deg
Transistor Drop	2	V
Diode Drop	2	V

Figure 9. Input circuit parameter.

Slot

Name	Value	Unit	
Auto Design	☐		Auto
Parallel Tooth	☐		Desi
Hs0	2	mm	Slot c
Hs1	1	mm	Slot c
Hs2	30	mm	Slot c
Bs0	2	mm	Slot c
Bs1	6	mm	Slot c
Bs2	12	mm	Slot c
Rs	0.6	mm	Slot c

Figure 10. Input stator slot parameter.

Properties: bldc motor - RMxpertDesign1 - Machine

Winding		End/Insulation	
Name	Value	Unit	Evaluated V..
Winding Layers	2		
Winding Type	Whole-Coiled		
Parallel Branches	1		
Conductors per Slot	15		15
Coil Pitch	1		
Number of Strands	0		0
Wire Wrap	0.2	mm	
Wire Size	Diameter: 1.369mm		

Figure 11. Input stator winding parameter.

After putting all parameter value of stator shown in Figure 12.

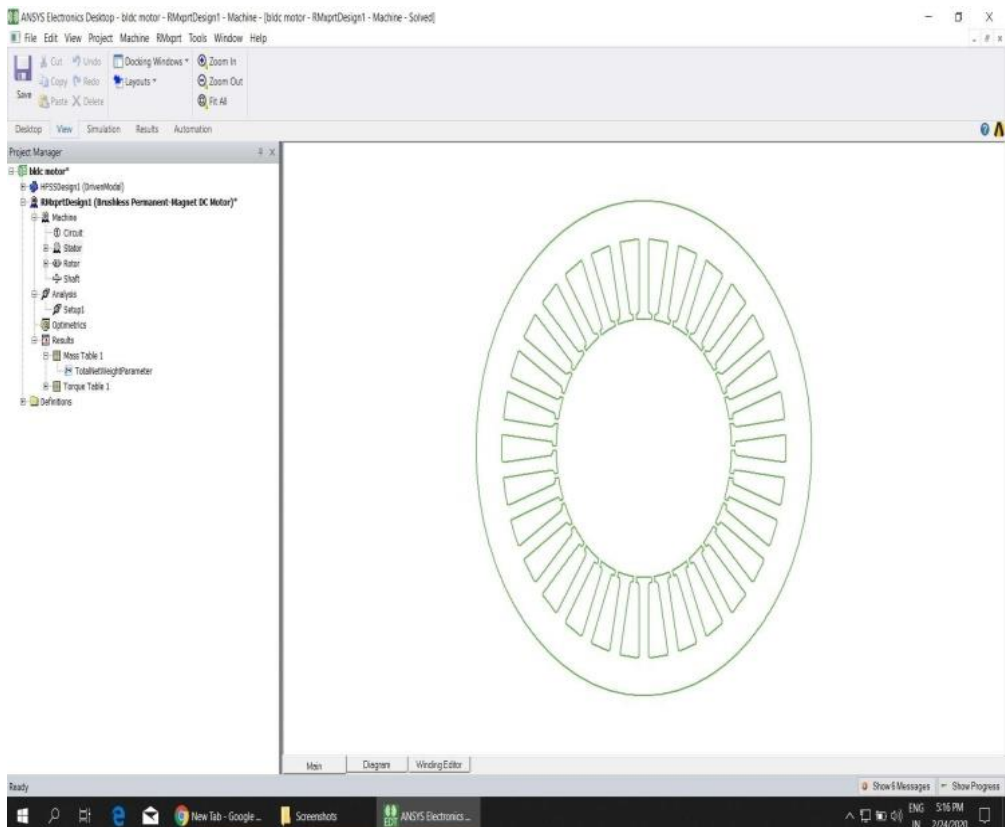


Figure 12. Stator design.

CHOICE OF ROTOR

Tape the Rotor cage and enhance it, you will occur the cage; pole, shaft etc. and give the parameters in its related tables. Input rotor parameter shown in Figure 13 while Input rotor pole parameter is shown in Figure 14.

Rotor

Name	Value	Unit
Outer Diameter	108	mm
Inner Diameter	40	mm
Length	50	mm
Steel Type	steel_1010	
Stacking Factor	0.95	
Pole Type	1	

Figure 13. Input rotor parameter.

Properties: bldc motor - RMxpertDesign1 - Machine

Pole

Name	Value	Unit	Evaluated V...	
Embrace	0.9		0.9	Pole embri
Offset	4	mm	4mm	Pole-arc c
Magnet Type	NdFe35			Magnet ty
Magnet Thickness	4	mm	4mm	Maximum

Figure 14. Input rotor pole parameter.

After putting all parameter value of rotor shown in Figure 15.

CHOICE OF ANALYSIS

Tape the analysis cage and enhance it, you occur the cage optometrist, result. After tape the results, you will occur the RMXPERT results with many types of graph like Input dc current V/s speed, efficiency V/s speed, output power V/s speed etc. A complete machine design is shown in Figure 16.

RESULTS AND PERFORMANCE ANALYSIS FROM RMXPERT

Coming curves and script get in RMXPERT result for fixed case respond. Figure 17 represent relation between Speed V/s Torques [9].

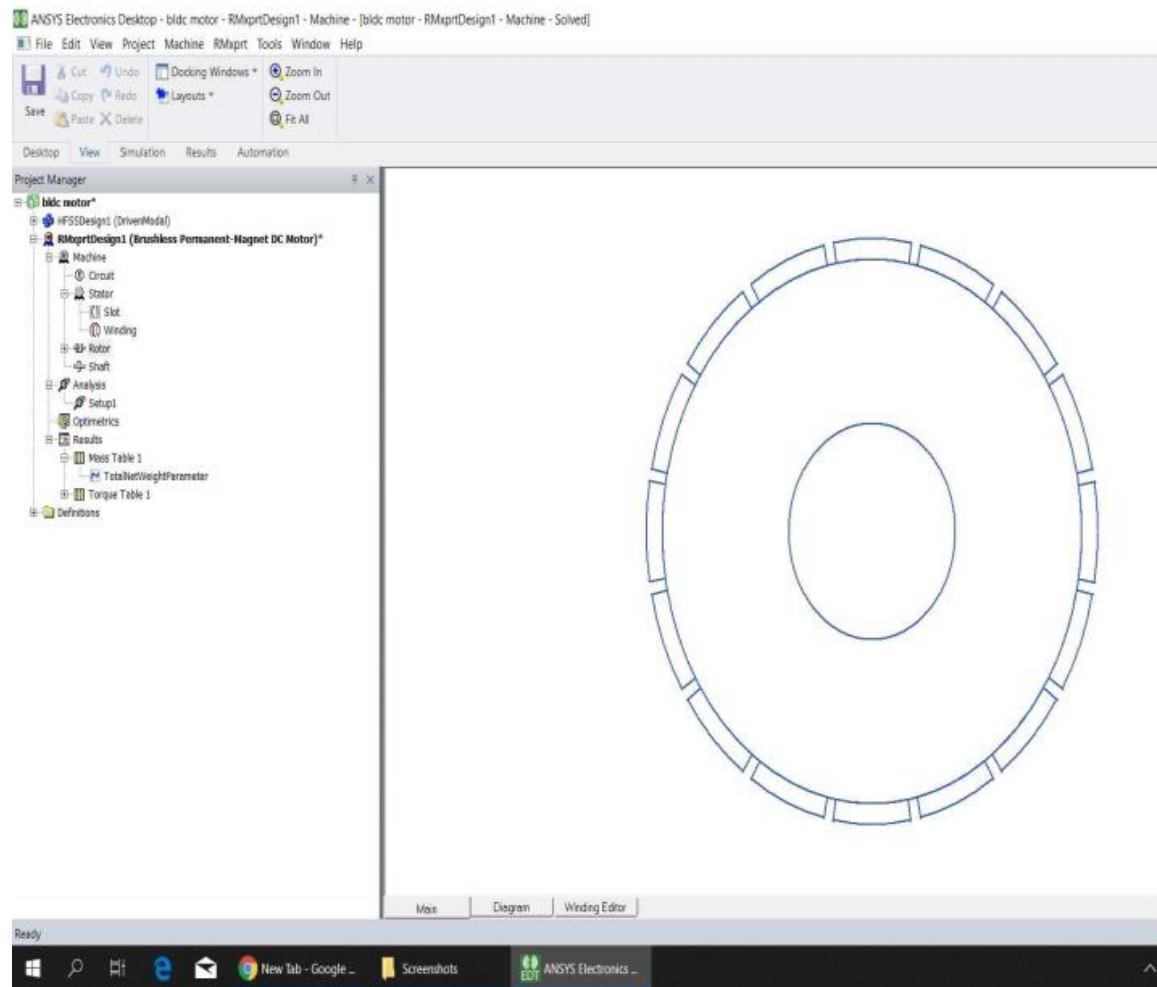


Figure 15. Rotor design.

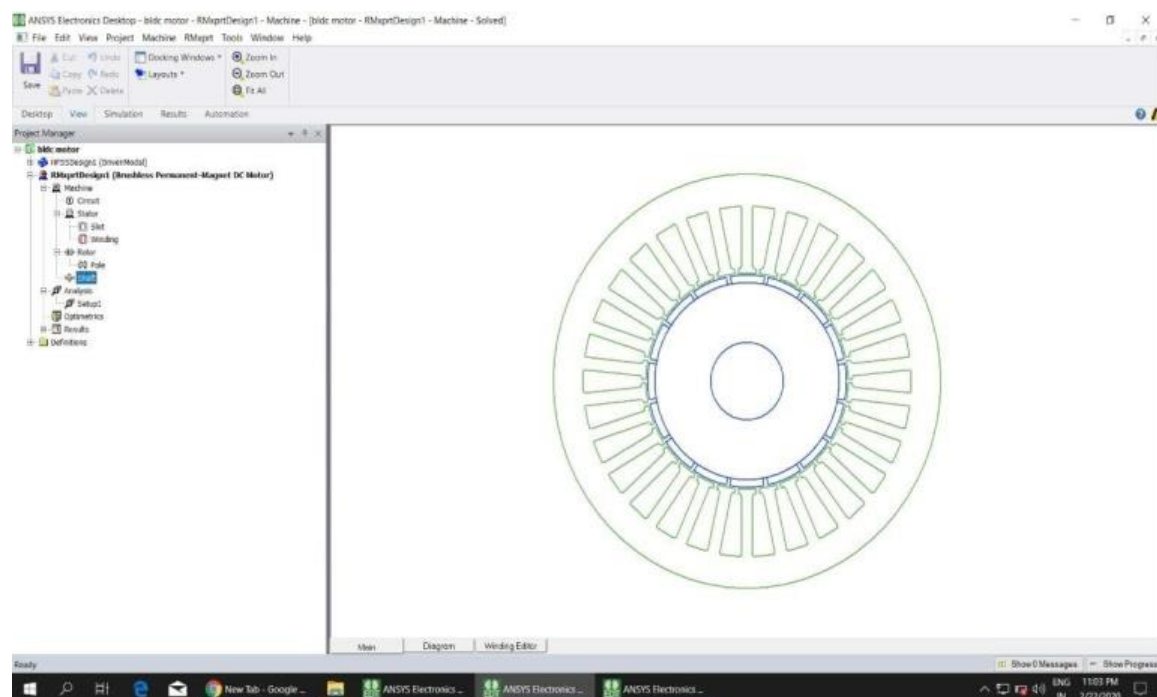


Figure 16. Complete machine design.

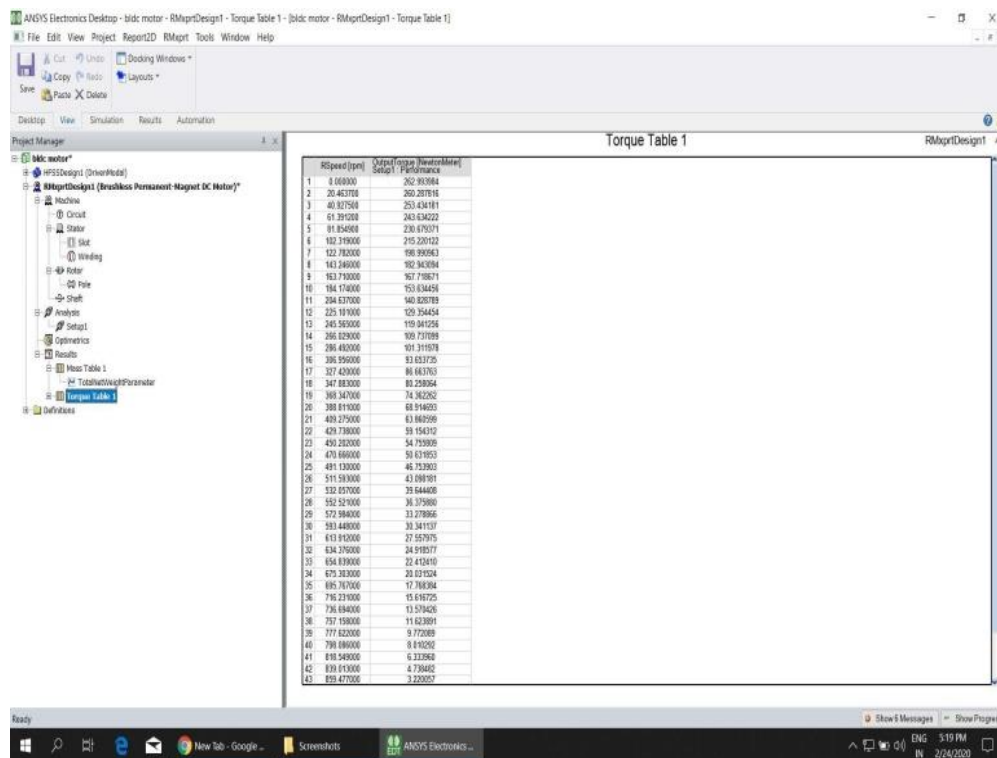


Figure 17. Speed V/s Torques.

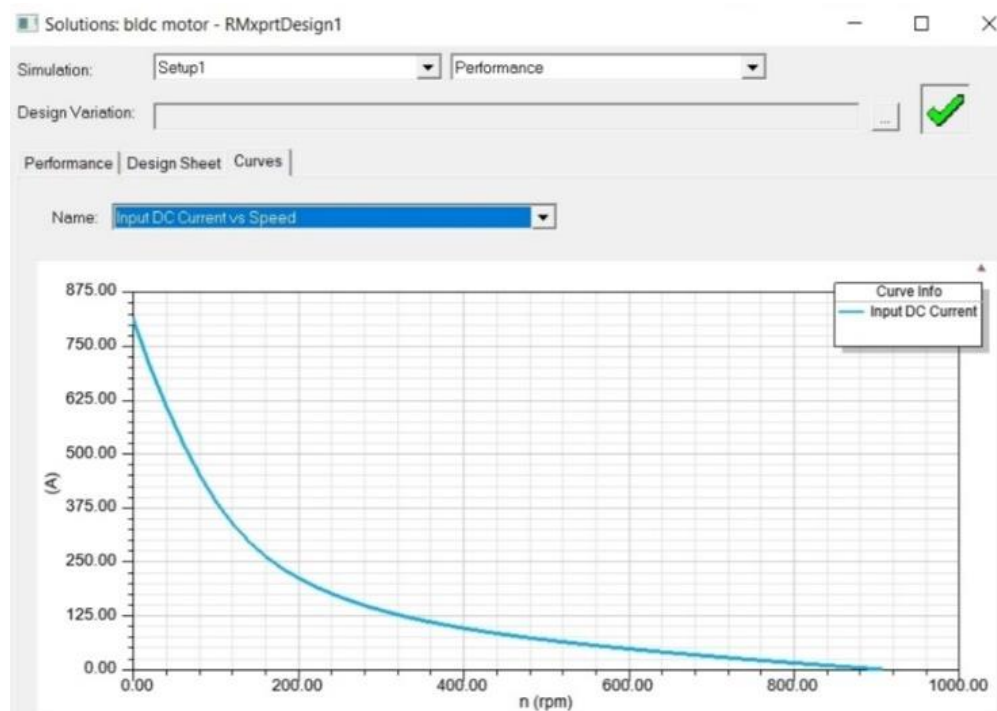


Figure 18. Input DC current V/s Speed.

As shown in Figure 18, when speed between 600 rpm to 800 rpm hence input dc current will be decrease.

As shown in Figure 19, when speed between 600rpm to 800 rpm hence efficiency will be high. Air-gap flux density graph is shown in Figure 20 [10, 11].

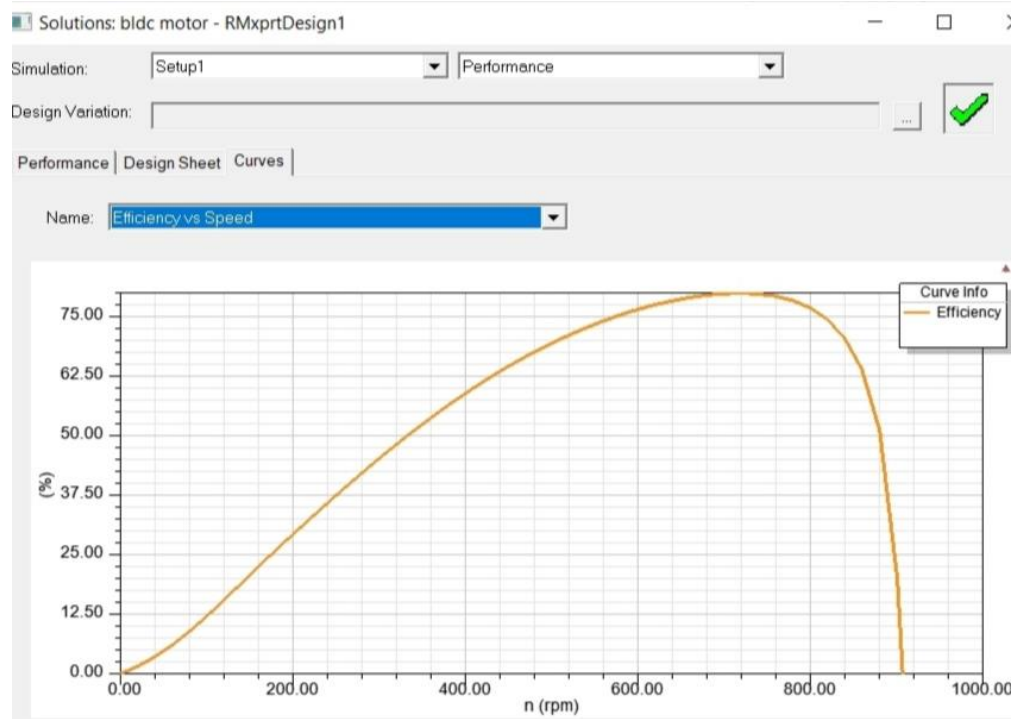


Figure 19. Efficiency V/s Speed.

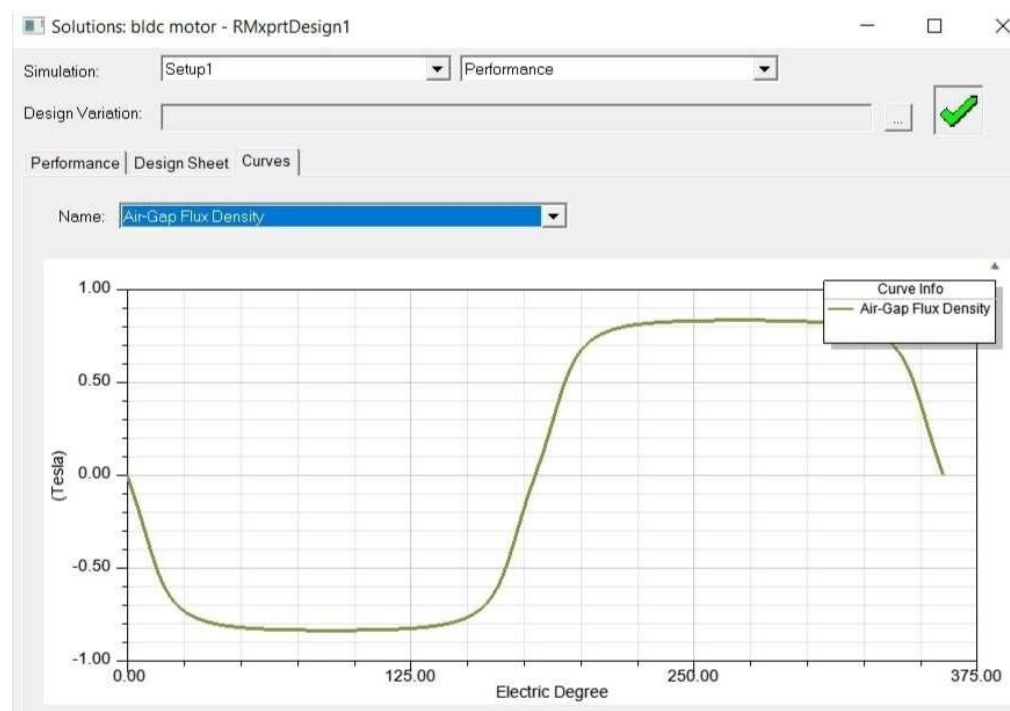


Figure 20. Air-gap flux density.

CONCLUSION

This paper describes the how to creation and simulation of simple PMDC Motor using ANSYS Maxwell Software. The BLDC Machine was selected as a motor for exalted execution e-bike. Opening Machine dissection in RMXPERT modulus of Maxwell visible that the efficiency of the machines greatly. The RMXPERT using basic design and intractable illusion. It data is not perfect for finalization the car volition parameter. This is too necessary to go for the limited essence Analysis

resources of ANSYS scilicet Maxwell 2D. Since pretension, we completed the motorcar formation source material, than outgrowth in capacity. Finite Element method (FEM) explication and using standard software explication and optimize the overall performance.

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