THE HASHMITE UNIVERSITY

ELECTRICAL ENGINEERING DEPARTMENT

ELECTRICAL MACHINES LAP

LAP REPORT # 3

DC-Shunt Motor

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Objectives:

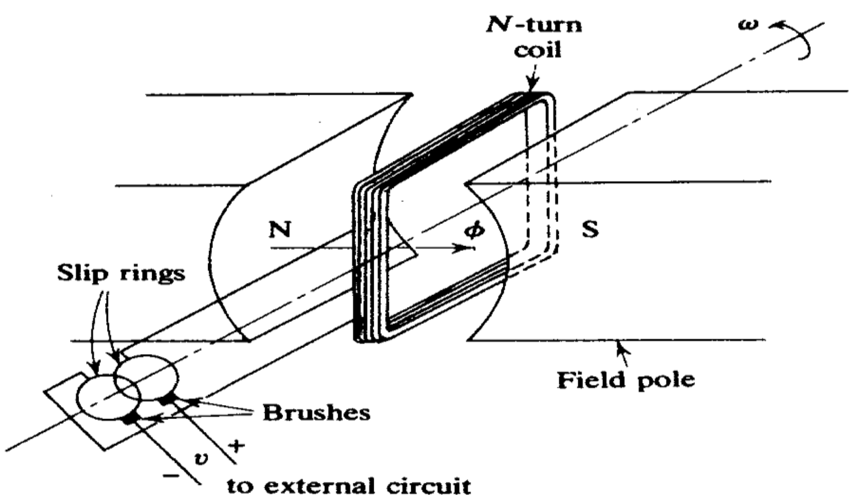
The objective of this experiment is to determine how we can control the speed of the motor using armature voltage control and filed resistor control, and to determine the torque and efficiency characteristics, and to learn the two methods used to reverse the direction of rotation of the motor.

Theoretical Background:

DC machines are motors that convert electrical energy to mechanical energy to mechanical energy and generators that convert mechanical energy to electrical energy.

The construction for all DC machines is the same with few minor changes in the connection between armature and the field circuit.

The general DC Machine is shown below:

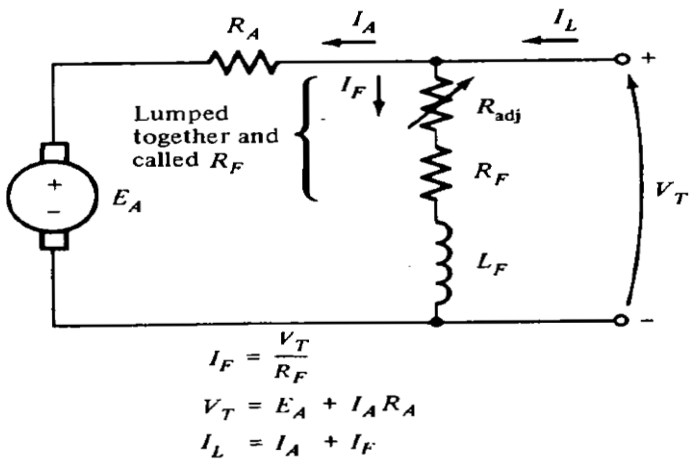


General Dc Machine

In this machine an external dc voltage source is connected directly to the armature circuit and current flows throw the coils , the interaction between the magnetic field and the current will result in a rotational motion of the coils and the shaft is moved by this motion .

The shunt motor is the same as the separately excited motor with only one minor difference , that is the field circuit in the shunt motor is connected to the armature terminal , while in the separately excited motor the field is supplied with an independent voltage source .

The following figure shows the equivalent circuit of the shunt motor :



Equivalent circuit of the DC shunt motor

Vt : the terminal voltage (voltage supplied to the motor) .

Rf & Lf =: the field coil resistance and inductance .

Ra : Armature resistance .

If = field current .

Il = load current . *Ea : internal generated voltage in the coils .*

There are three ways in which we can control the speed of the shunt motor :

1.Changing the field resistance :If the field resistance is increased , the field current decreases and the flux also decreases and since $Ea = K\Phi\omega$ the internal generated voltage decreases , but Ia increases and with its increase over come the decrease in the flux Φ the induced torque increases ($\tau = K\Phi Ia$) and the speed also increased , With the speed increase Ea increase and Ia decreased until the induced torque equals the load torque at higher speed .

2. Changing the armature voltage: (without changing the field voltage , power electronic devices are used to accomplish this task)If the armature voltage is increased then Ia increases and the torque increases ($\tau = K\Phi Ia$) and the speed increases , but as the speed increases Ea also increases $Ea = K\Phi\omega$, and Ia decreases until τ induced = τ load .

3.Increaseing Ra (series resistance with the armature) since the torque -speed characteristics is :

$$\omega = \frac{Vt}{K\Phi} - \frac{Ra}{(K\Phi)^2}\tau$$

Increasing Ra will result in slower speed operation of the motor if loaded, this method is rarely used because it's a very wasteful method .

Equipments :

We used a set of millimeters to measure currents and voltages a variable load , a torque measuring unit , and of course the DC shunt motor .

Procedure :

A. Measuring some characteristics of DC Shunt motor:

We first noted the rating plate an saw the values that we should not exceed in our experiment , then we used the practical diagram to connect the motor , we set starting resistance to maximum value (in order to avoid high starting current), then we started the motor and slowly decreasing the starting resistance and we saw how the speed of the motor increased , we set If to .28 A and we started to increase Ia keeping the terminal voltage fixed at 220 V , we obtained the following results :

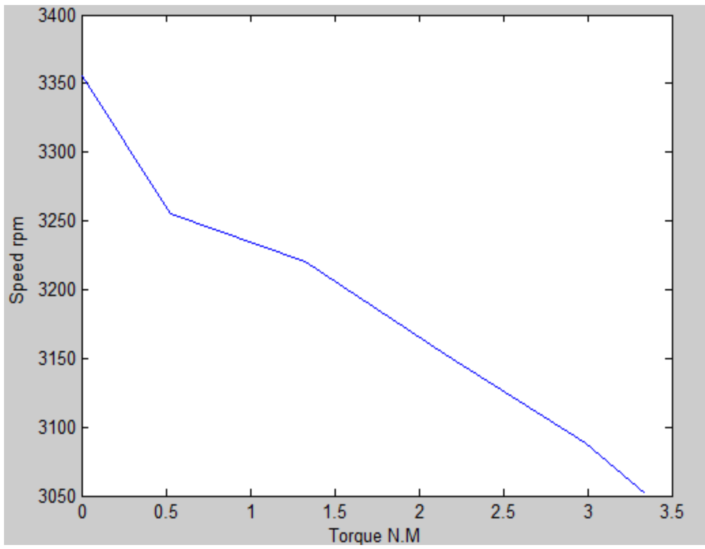
Ia (A)	Pin(watt)	n(rpm)	τ (N.m)	Pout(watt)	η%
.5	171.6	3355	0	0	0
1.5	391.6	3255	.53	180.65	46.13
3	721.6	3220	1.33	448.472	62.14
4.5	1051.6	3153	2.16	713.19	67.82
6	1381.6	3088	2.99	966.89	69.98
6.7	1535.6	3052	3.34	1067.48	69.5

Note : we used the relations :

Pin =(Ia +If).Vt $\quad$ *Pout =* $\tau \cdot \dfrac{\pi . 2 . n}{60}$ *and* *η%=(Pin / Pout). 100%*

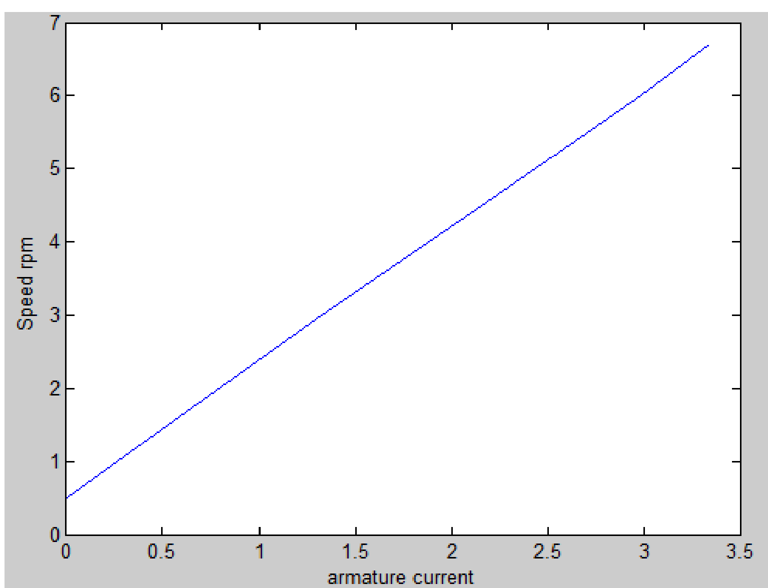
Questions :

1.Plot speed versus torque curve .

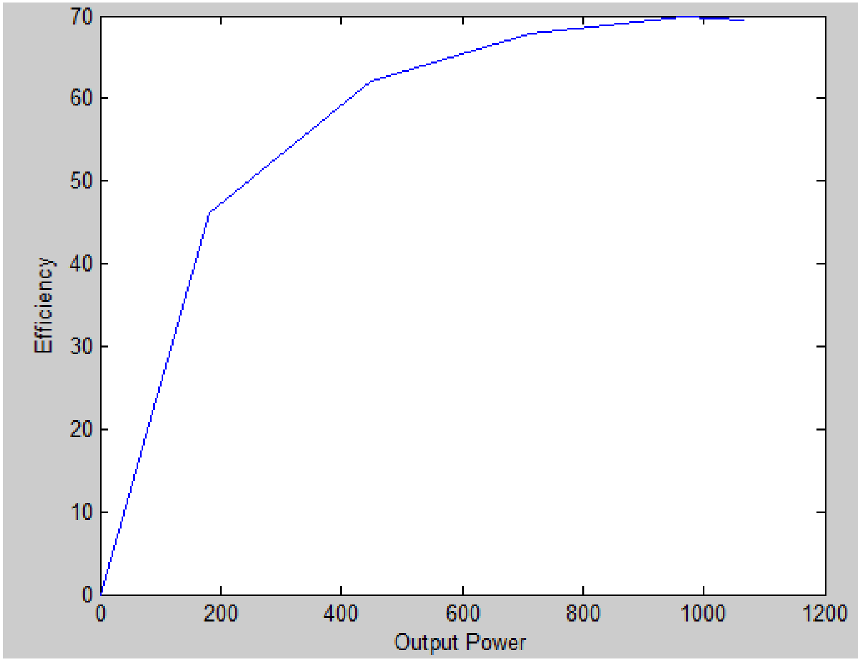


Note: almost a straight line (due to error) and the lowest value on the y axis is 3050 for accuracy .

2.Plot speed versus armature current curve .



3.Plot efficiency versus output power curve .



4.Explain the nature of the cuvres in question 1 , 2 and 3 .

In question one the relation between the speed and the torque is inverse linear relation .

$$\omega = \frac{Vt}{K\Phi} - \frac{Ra}{(K\Phi)^2}\,\tau$$

In question two the relation is linear and directly propotional .

In question three the relation is nonlinear but the efficiency is directly propotional to the output power untill a certain value then to efficency is constant .

B.Speed control od DC Shunt motor :

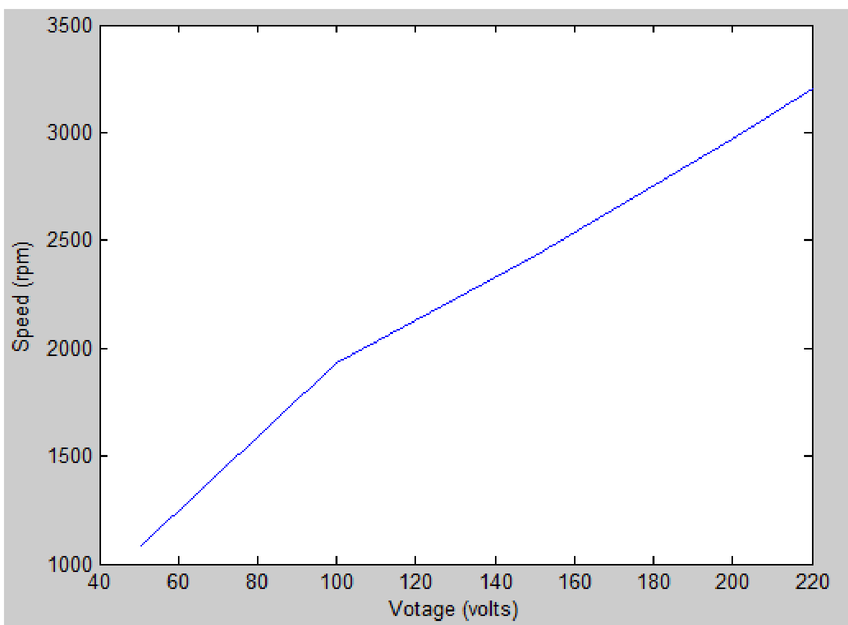
1. By Alternating the terminal voltage :

We used the same connection as before , we decreased Ia to 3 A and we started taking measurements of Ia and If with decreasing the value of Vt , we obtained the following results :

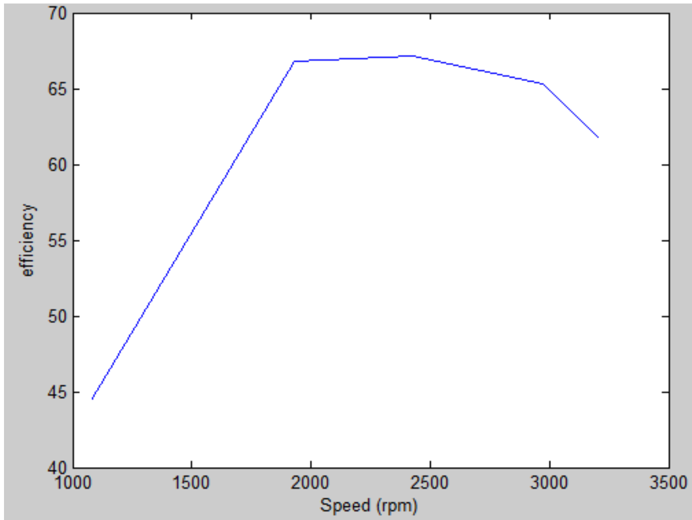
If (A)	Ia (A)	Vt	Pin(watt)	n(rpm)	τ (N.m)	Pout(watt)	η%
.28	3	220	721.6	3206	1.33	446.52	61.8
.24	3	200	648	2973	1.36	423.4	65.34
.18	3.25	150	514.5	2426	1.36	345.5	67.15
.12	4	100	412	1932	1.36	275.15	66.78
.06	6.7	50	338	1078	1.33	150.14	44.4

Questions :

1.Plot speed versus voltage curve .



2.Plot efficiency versus speed curve .



3.Why the armature current is increasing when the terminal voltage is decreasing ?

When terminal voltage decrease, field current decrease , and flux decreases gradually (because of the transition between saturation region and linear region) , as the flux decreases , Ea also decreases and Ia increases .

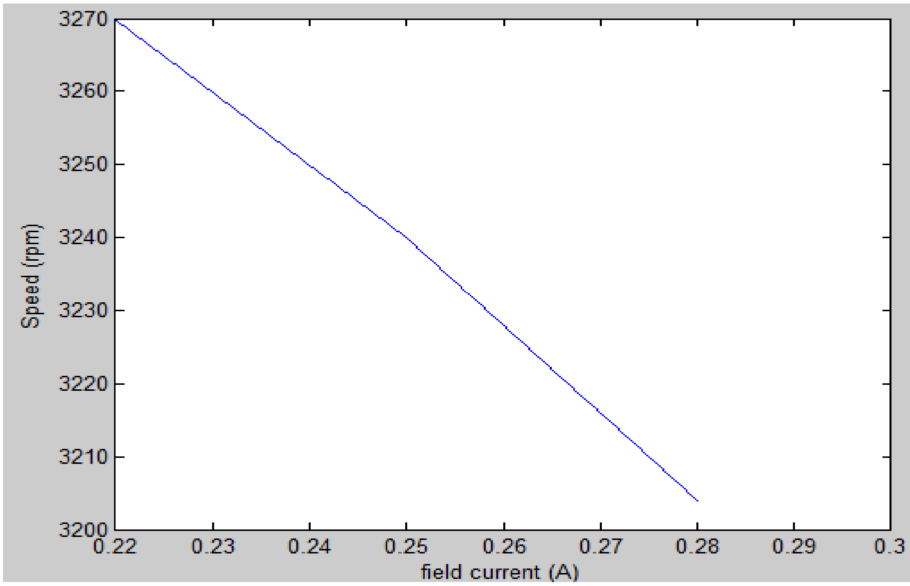
1. By Alternating the field resistance :

We used the same connection as before , we set the the starting resistance to maximum and increased terminal voltage to 220 and held it constant and then we turned of the starting resistance , we used the excitation rheostat to set the field current to .28 A and increased the load torque to 2 N.m and held it constant then we started decreasing the field current and take measurements of Ia and the speed :

If(A)	Ia(A)	N(rpm)	η%
.28	2.85	3204	97.45
.25	2.88	3240	98.5
.22	2.91	3270	99.45

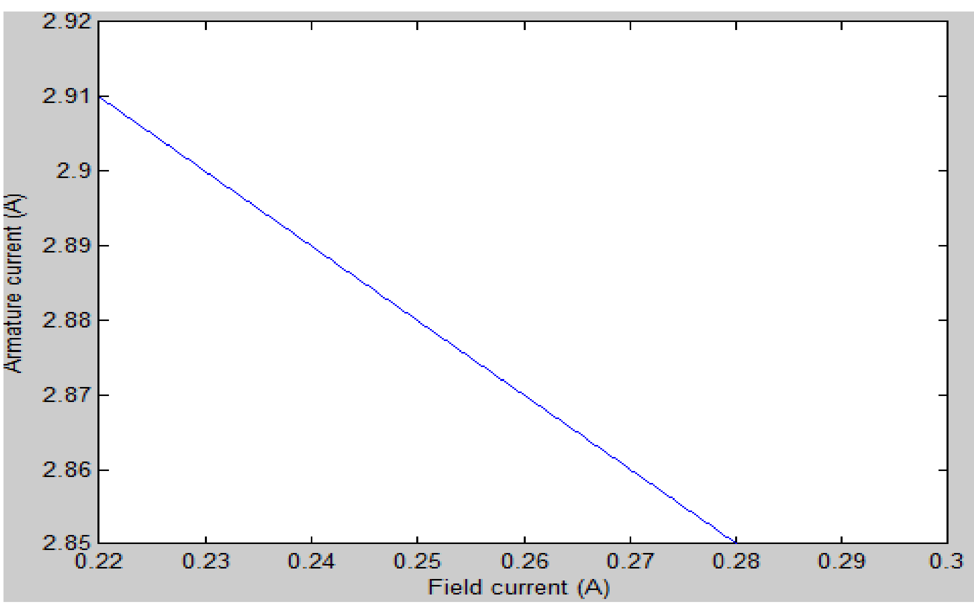
Questions :

1.Plot the curve of speed versus field current , and explain the nature of the curve .



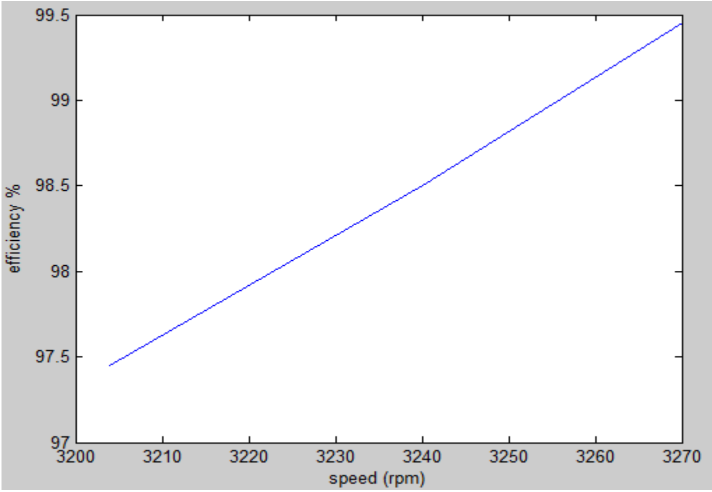
As the field current increases the speed decreases (inverse relation) .

2.plot the curve of the armature current versus field current , and explain the nature of the curve .



The relation is inverse linear because Ia = Il (constant) – If .

3.Plot efficency versus speed curve .



4.What happens to speed when the excitation rheostat is increased ?

The speed increase : If the field resistance is increased , the field current decreases and the flux also decreases and since Ea = KΦω the internal generated voltage decreases , but Ia increases and with its increase over come the decrease in the flux Φ the induced torque increases (τ = KΦIa) and the speed also increased , With the speed increase Ea increase and Ia decreased until the induced torque equals the load torque at higher speed .

5.Can the speed of shunt motor be reduced by varing field resistance ? why?

We can increase the speed as in the previous question or we can decrease the speed as follows :

If the field resistance is decreased , the field current increase and the flux also increase and since Ea = KΦω the internal generated voltage increase , but Ia decreases and with its decrease over come the increase in the flux Φ the induced torque decreases (τ = KΦIa) and the speed also decreased , With the speed decreased Ea decease and Ia increased until the induced torque equals the load torque at lower speed .

C. Reversing direction of rotation od DC shunt motor .

Questions :

1.If the direction of the current through the field is changed , what happenes ?

2.If the direction of the current through the armature is changed , what happenes ?

Answre for question 1 & 2 : We reversed the direction by changing the direction of the armature current or the direction of the field current (one at a time) .

3.If the direction of the current through the field and the armature is changed , what happenes ? explain why ?

if we reversed both directions the effect cancels and the motor rotates in the original direction .

Conclusions:

1. We learned how make connections of the DC shunt motor and how to measure different parameters.

2. we learned how to control the speed of rotation of the motor in one of three methods : the terminal voltage , the excitation resistance (field current) and the armature resistance .

3. We learned how we can inverse the direction of rotation of the motor in two ways : changing the direction of either the field current or the armature current.