Title of the Exercise: Exercise 6 : Long shunt DC motor

Date: 18/09/2020

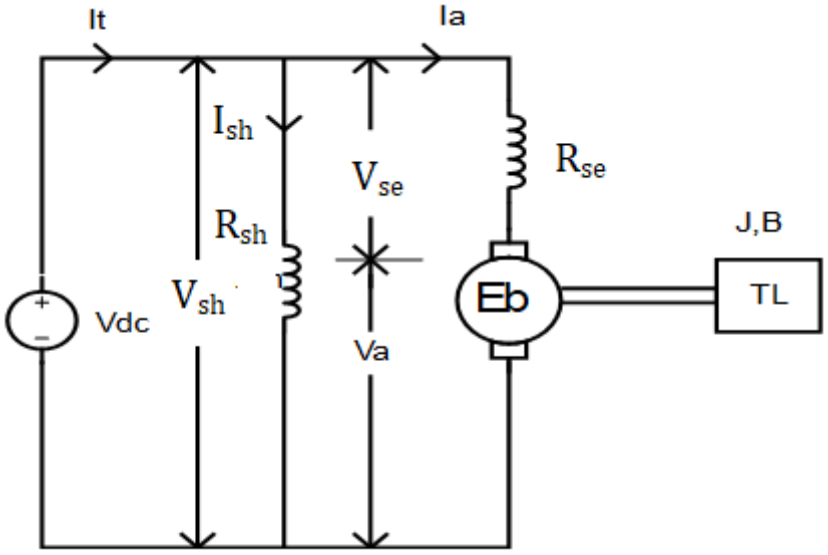
Aim

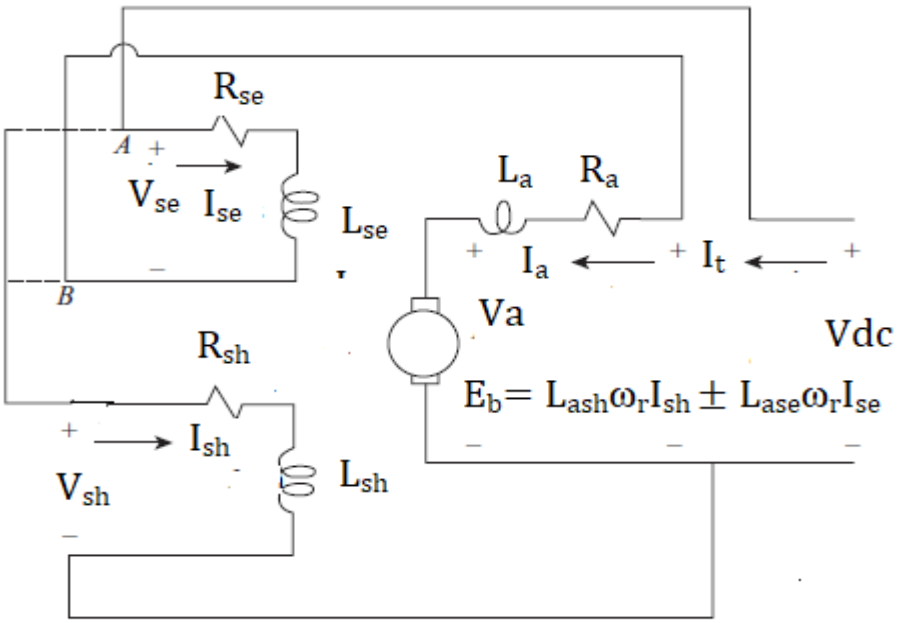
To Simulate the dynamic modal of a long shunt DC motor plot various characteristics curves and analyse the results.

Tool used :

MATLAB

Electrical Circuit





Parameters Used for study:

Input voltage V_{dc}=230,
Armature resistance R_a = 1.50 ohms
Armature winding self inductance L_a=0.12H
Mutual inductance between armature and main field L_{ash}=1.8H
Mutual inductance between armature and series field L_{ase}=0.0018H
Shunt field winding resistance R_{sh}=270 ohm
Shunt field winding Self inductance L_{sh}=0.03H
Mutual inductance between series and Shunt field L_{shse}= 0.001H
Self inductance of series field winding L_{se}=0.012 H
Series armature winding resistance R_{se}=0.7ohms
Back emf constant or torque constant K=0.0141
Moment of inertia J=0.02365
Friction coefficient B=0.0025
Rated load=2.5HP

Theoretical Analysis

$V_{dc}=V_{sh}$
$V_{dc}=V_a+V_{se}$
$I_t= I_{sh}+I_{se}$
$I_{se}=I_a$
$V_{dc}=I_{sh} R_{sh}$
$V_{dc}=V_{se}+V_a=I_a(R_{se}+R_a)+E_b$

$V_{sh}=R_{sh} I_{sh} + L_{sh} \frac{dI_{sh}}{dt} \pm L_{shse} \frac{dI_{se}}{dt}$
$V_{se}=R_{se}I_{se}+ L_{se}\frac{dI_{se}}{dt} \pm L_{shse}\frac{dI_{sh}}{dt}$
$V_a=R_aI_a+ L_a\frac{dI_a}{dt}+ L_{ash}\omega_r I_{sh} \pm L_{ase}\omega_r I_{se}$
$E_b= L_{ash}\omega_r I_{sh} \pm L_{ase}\omega_r I_{se}$
$T_e=L_{ash} I_{se} I_{sh}\pm L_{ase} I_{se} I_a$
$T_e=T_L + J\frac{d\omega}{dt} +B\omega$

Calculations (Predetermination):

In steady state:

$dI_a/dt = 0$
$dI_{sh}/dt = 0$
$dw/dt = 0$

then we get

$V_{sh} = R_{sh}I_{sh}$

$V_{se} = R_{se}I_{se} = R_{se}I_a$

$V_a = R_aI_a + E_b$
$V_b = L_{ash}W_rI_{sh} + L_{ase}W_rI_{se}$

$= L_{ash}W_rI_{sh} + L_{ase}W_rI_a$

$T_e = L_{ash}I_{sh}I_a + L_{ase}I_a^2$

$T_e = T_l + B_{Wr}$

Substituting the values
V_{dc}=230
R_a = 1.50 ohms
L_a=0.12H
L_{ash}=1.8H
L_{ase}=0.0018H
R_{sh}=270 ohm
L_{sh}=0.03H
L_{shse}= 0.001H
L_{se}=0.012 H
R_{se}=0.7ohms
K=0.0141
J=0.02365
B=0.0025

We get

$I_{sh} = V_{sh}/R_{sh}$ =230/270 = 0.851A

$V_a = 230 – 0.7Ia$ ----------Eqn 1
$V_a = 1.5I_a + 1.8*0.852W_r + 0.0018W_rI_a$ ----------Eqn 2
$T_e = 10 + 0.0025W_r$ ----------Eqn 3
$T_e = 1.8*0.852I_a + 1.8T_a^2$ ----------Eqn 4

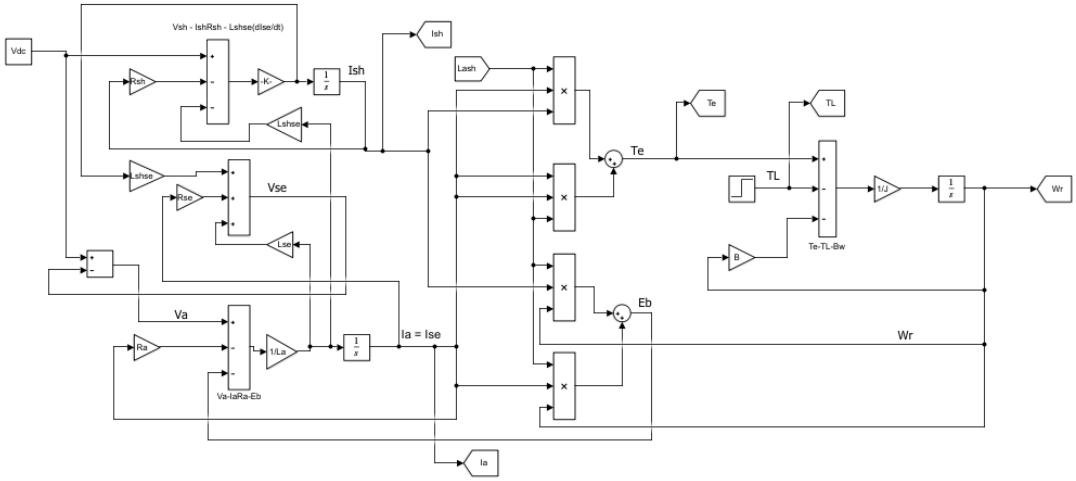
On solving the equations we get

I_a = 1.99A
T_e = 10.11Nm
W_r = 44.22rad/sec
E_b = 67.89V

Procedure for simulation study:

1)Write down the mathematical equations according to the circuit diagram
2)Make the m file and initialse all the the constants in it
3)Open a blank Simulink model and make the Simulink model according to the equations
4)save the Simulink file and run it
4)Note the readings from the scope

Simulation Diagram and m.file coding




```
Vdc=230;
Ra=1.50;
La=0.12;
Lash=1.8;
Lase=0.0018;
Rsh=270;
Lsh=0.03;
Lms=0.0018;
Lshse=0.001;
Lse=0.012;
Rse=0.7;
K=0.0141;
J=0.02365;
B=0.0025;
disp('run simulation,type "return" when ready to return')
keyboard
subplot(6,1,1)
plot(out.y(:,1),out.y(:,2))
title('Armature voltage')
ylabel('Va in Volts')
subplot(6,1,2)
plot(out.y(:,1),out.y(:,3))
title('Armature Current')
ylabel('Ia in A')
subplot(6,1,3)
plot(out.y(:,1),out.y(:,4))
title('Electromagnetic torque')
ylabel('Te in N/m')
subplot(6,1,4)
plot(out.y(:,1),out.y(:,5))
title('Speed')
ylabel('w in m/s')
subplot(6,1,5)
plot(out.y(:,1),out.y(:,6))
title('Winding current')
ylabel('Ish in A')
subplot(6,1,6)
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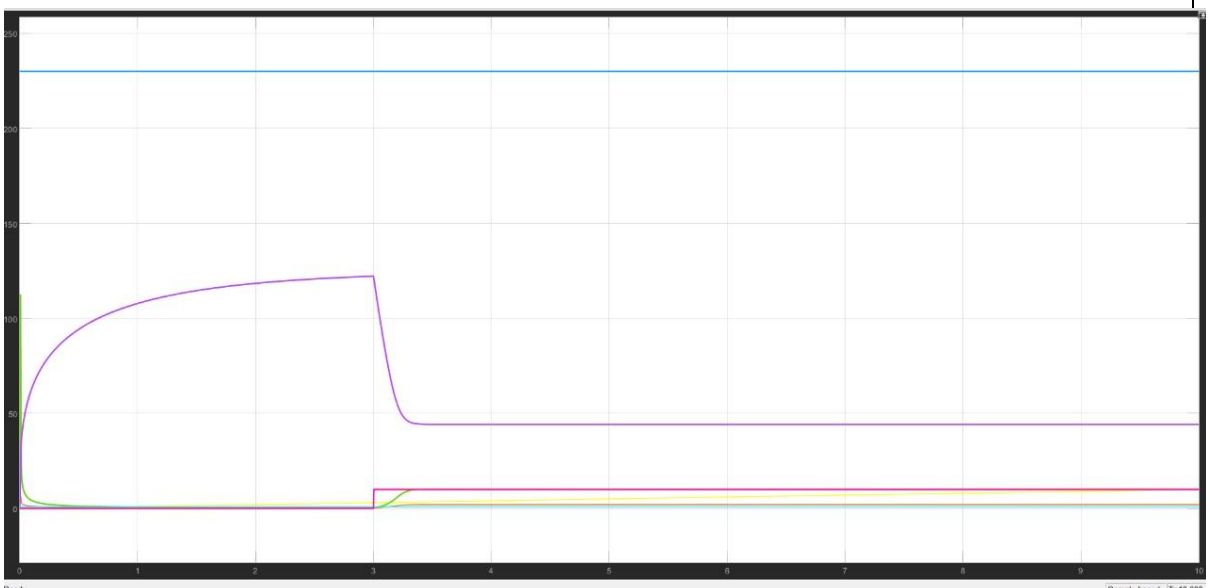
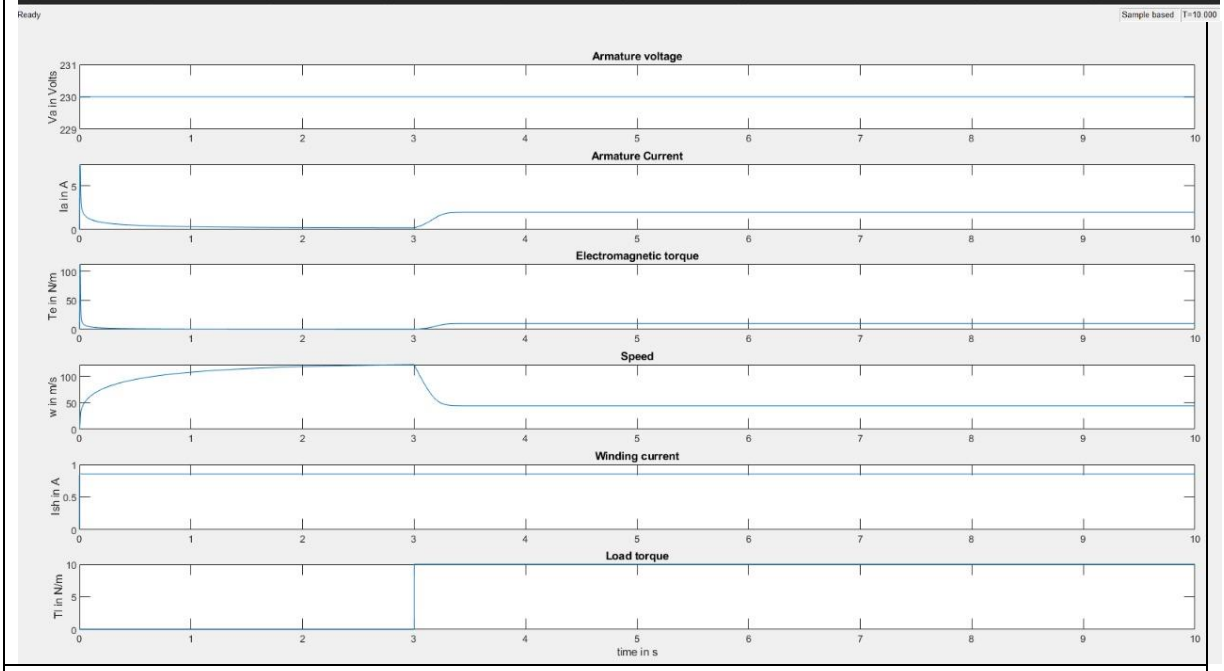
```
plot(out.y(:,1),out.y(:,7))
title('Load torque')
ylabel('Tl in N/m')
xlabel('time in s')
```

Results and Discussions:





Comparison (Observations)

Parameters	Theoretical Value	Simulation Value
I_a(A)	1.99	1.98
T_e(Nm)	10.11	10.01
W_r(rad/sec)	44.2	44.23

Conclusion:

Experiment performed successfully and theoretical values match the simulation values.

Inference

The dynamic model of a long shunt dc compound motor gives the variation of:

- Armature current
- Speed
- Electromagnetic torque with respect to time.

The variation of these parameters under 2 conditions, i.e no load condition and loaded condition is obtained from the scope.

Initially, these parameters vary rapidly, but with time they attain a constant steady state value.

References: NIL