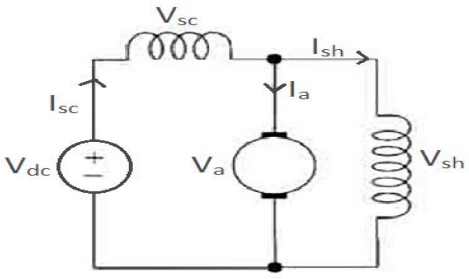
Title of the Assignment: SHORT SHUNT DC COMPOUND MOTOR

Date: 18/09/2020

Aim: To develop and simulate mathematical dynamic modal of a Short Shunt DC Compound Motor and also analyze its theoretical results.

Tool used: MATLAB and Simulink

Electrical Circuit:



Parameters used for the study:

Input voltage, V_{dc} = 230 V
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:

$V_a = I_a.R_a + L_a.(dI_a/dt) + E_b$

$V_{sh} = I_{sh}.R_{sh} + L_{sh}.(d\,I_{sh}/dt) + L_{sh}.(dI_{sc}/dt)$

$V_{sc} = I_{sc}.R_{sc} + L_{sc}.(dI_{sc}/dt) + L_{shsc}.(dI_{sh}/dt)$

$E_b = L_{ash}.\omega.I_{sc} + L_{ash}.\omega.I_{sh}$

$T_e = L_{ash}.I_a.I_{sc} + L_{ash}.\omega.I_{sh}$

$T_e = T_l + B.\omega + j(d\omega/dt)$

$V_{dc} = V_a + V_{sc} = V_{se} + V_{sh}$

$V_a = V_{sh}$

Calculations (Predetermination)

At steady state:

$dI_a/dt = 0$, $dI_{sc}/dt = 0$, $dI_{sh} = 0$,
$V_a = I_aR_a + E_b$
$V_{sh} = I_{sh}R_{sh}$
$V_{sc} = I_{sc}R_{sc}$
$V_a = 1.5\ I_a + E_b$
$T_e = 10 + B.\omega$
$V_{sh} = 270RI_{sh}$
$V_{sc} = 0.7*I_{sc}$
$T_e = 10 + 0.0025\omega$
$T_e = 1.8I_a\ (I_{sc} + I_{sh})$
$E_b = 1.8\omega(I_{sc} + I_{sh})$

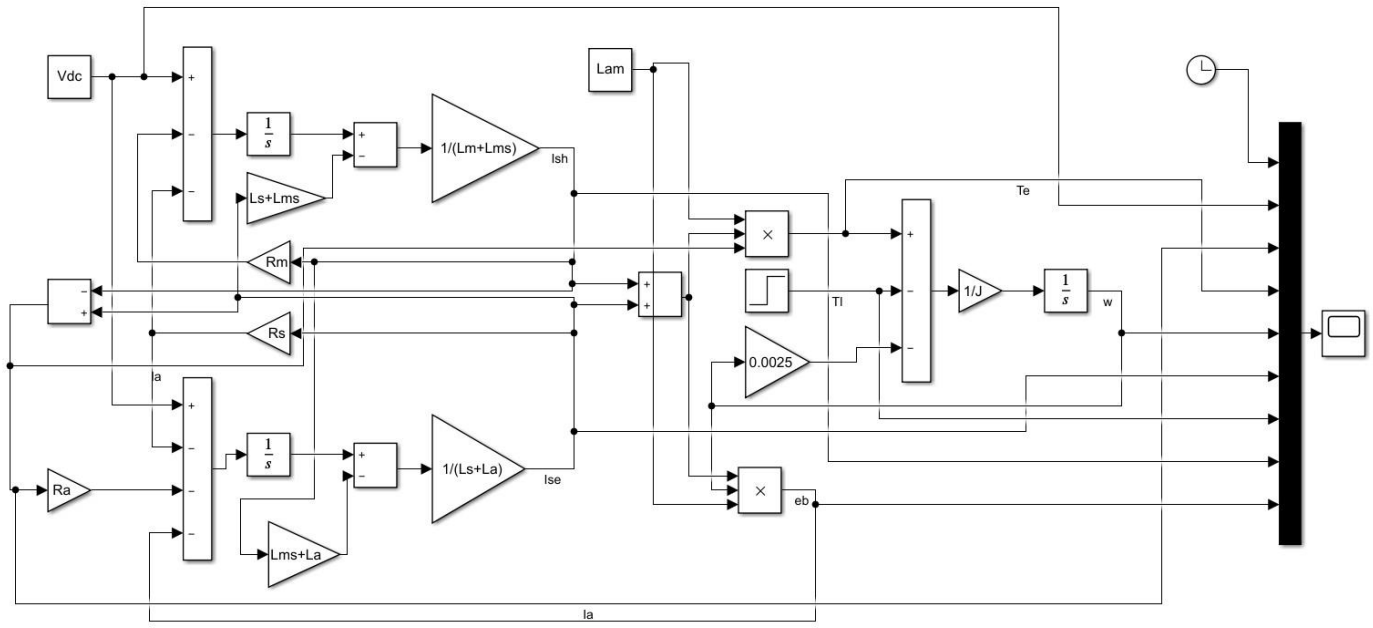
On solving we the above equations we get

$E_b = 220.34$ V
$\omega = 36.443$ rad/s
$I_{sc} = 2.515$ A
$I_a = 1.67$ A
$I_{sh} = 0.845$ A
$T_e = 10.09$

Procedure for simulation study:

- Write the coding for initializing the input parameters and as per requirement of plots in m file and save it.
- Open new Simulink file and make mathematical modelling as per circuit diagram and save it.
- Run the m file first, after that run Simulink file.
- View the result in Scope.
- Again, run m file and view the plots.
- Make various plots and write the results.

Simulink model and m file



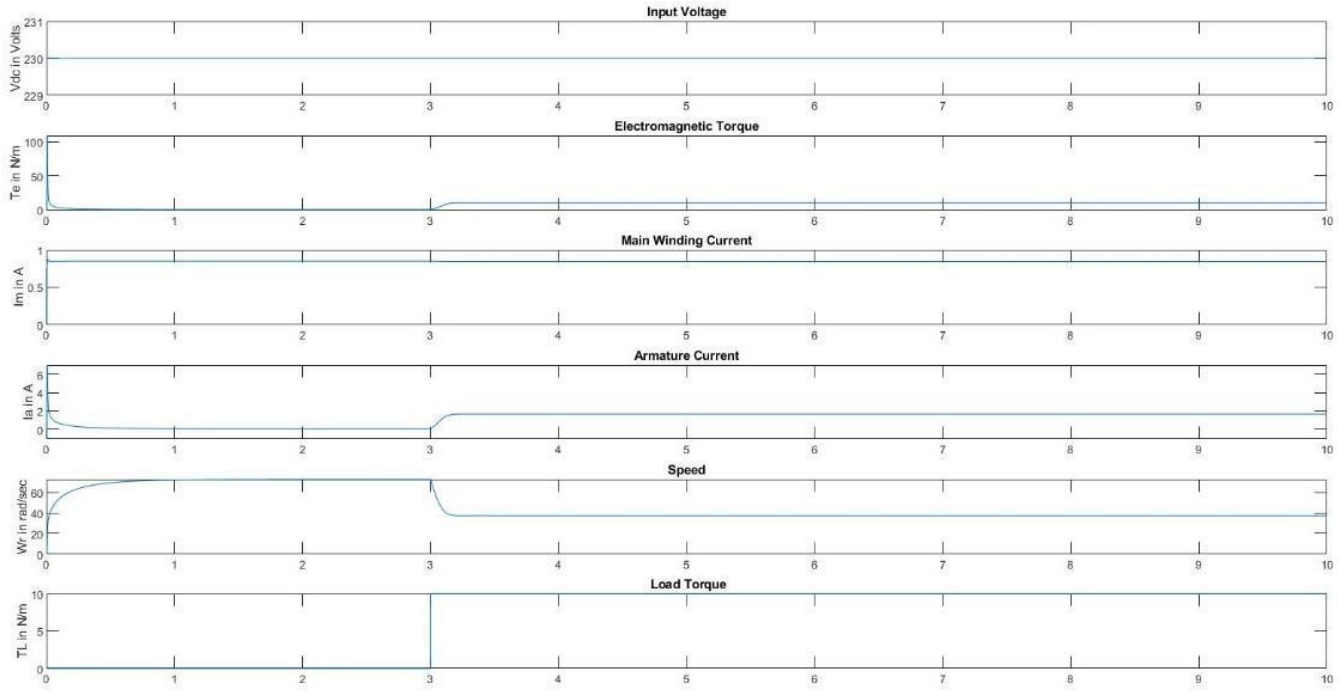
m file:

```
Vdc = 230;
Ra = 1.50;
Rm = 270;
Rs = 0.7;
La = 0.12;
Lam = 1.8;
Las = 0.0018;
Lm = 0.03;
Lms = 0.001;
Ls = 0.012;
J = 0.02365;
K = 0.0141;
subplot(6,1,1)
plot(out.y(:,1),out.y(:,2))
title('Input Voltage')
ylabel('Vdc in Volts')
subplot(6,1,2)
plot(out.y(:,1),out.y(:,4))
title('Electromagnetic Torque')
ylabel('Te in N/m')
subplot(6,1,3)
plot(out.y(:,1),out.y(:,8))
title('Main Winding Current')
```

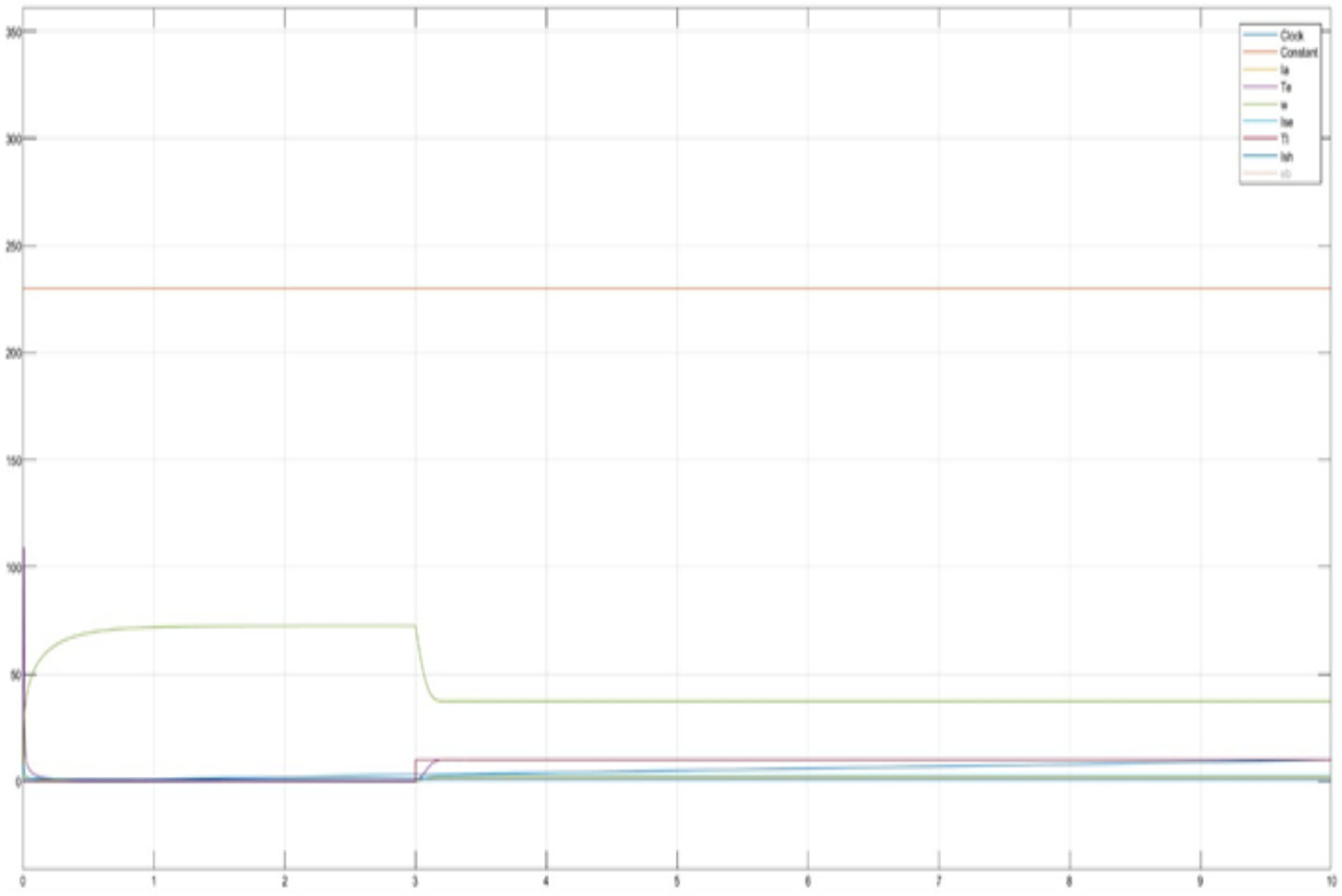
```
plot(out.y(:,1),out.y(:,3))
title('Armature Current')
ylabel('Ia in A')
subplot(6,1,5)
plot(out.y(:,1),out.y(:,5))
title('Speed')
ylabel('Wr in rad/sec')
subplot(6,1,6)
plot(out.y(:,1),out.y(:,7))
title(' Load Torque')
ylabel('TL in N/m')
```

Results and Discussions

Graph from M file



Scope output graph



Parameter	Value
$\mathbf{I_a}$	1.67 A
$\mathbf{T_e}$	10.09
ω	36.443 rad/s
$\mathbf{I_{se}}$	2.515 A
$\mathbf{E_b}$	220.34 V
$\mathbf{I_{sh}}$	0.845 A

Comparison (Observations):

Parameter	Theoretical Value	Simulation Value
$\mathbf{I_a}$	1.67 A	1.669 A
$\mathbf{T_e}$	10.09	10.091
$\boldsymbol{\omega}$	36.443 rad/s	37.33 rad/s
$\mathbf{I_{se}}$	2.515 A	2.514 A
$\mathbf{E_b}$	220.34 V	225.5 V
$\mathbf{I_{sh}}$	0.845 A	0.845 A

Conclusion: Hence the simulation values match with the theoretical values and a dynamic model of a DC short Shunt Motor has been successfully simulated.

Inference: Therefore, characteristic graphs of elements in the circuit are obtained and verified against theoretical values in steady state.

References:

- Simulink Onramp
- MATLAB onramp