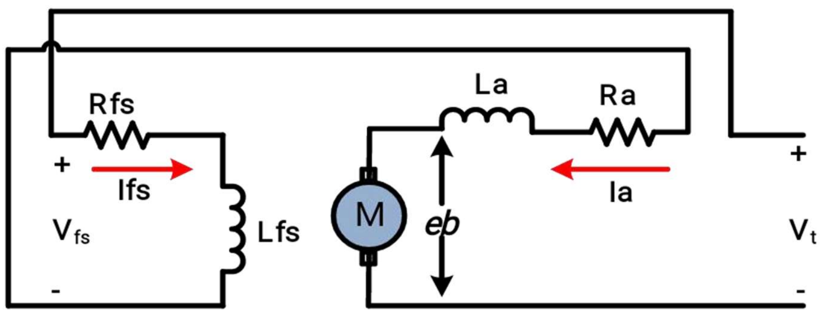
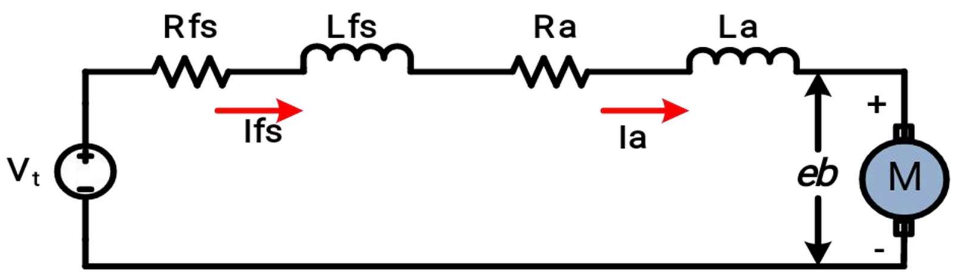
**Title of the Exercise: Series Excited DC motor**

**Date: 18.9.2020**

**Aim:** **To develop and Simulate mathematical dynamic model of DC Series motor and also analyze with theoretical results.** **Tool used:** **MATLAB and SIMULINK** **Electrical Circuit:**




$T_e = L_{af} * I_f * I_a = L_{af} * I_a^2$

**PARAMETERS USED FOR THE STUDY:**

Ra = 1.5; Armature resistance in ohm
La = 0.12; Armature Inductance in Henry
Lfs = 0.3; Field Inductance in Henry
Rfs = 0.7; Field Resistance in ohms
J = 0.02365; Moment of Inertia
B = 0.0025; Friction Coefficient in
Laf = 0.0675; Mutual Inductance between field and armature Henry
Va = 240; Supply DC voltage Va=240 volts

## THEORETICAL ANALYSIS:

In the motor mode, the field and armature of a dc series motor are supplied with the same current by an applied voltage, and a magnetic field (flux) is produced in the magnetic circuit.

## CALCULATIONS (PREDETERMINATION):

Applying Kirchoff's Voltage Law:

$$V_t = I_{fs} + R_{fs} + L_{fs} * dIf_s/dt + I_aR_a + L_a * dI_a/dt + e_b$$

Value of back emf (eb) is given by

$$E_b = I_f * L_{af} * w$$

But in series excited DC Motor, $I_{fs} = I_{fa} + I_a$

$$E_b = I_a * L_a * w$$

Electromagnetic torque equation is given by:

$$T_e = L_{af} * If * I_a$$

$$T_e = L_{af} * (I_a)^2$$

According to torque equation ,

$$T_e = Tl + j(d\cancel{w/}dt) + B*w$$

In steady state,

$$dI_a/dt = 0 \; ; \; dw/dt = 0$$

Therefore,

$$V_t = I_a(R_{fs} + R_a)$$

$$e_b = L_{af} * I_a$$

$$T_e = L_{af} * (I_a)^2$$

$$T_e = Tl + B * w$$

On substituting the input values to the above equations, we get:

$$1.8225\,(I_a)^2 - 537.2\,I_a - 240 = 0$$

$$I_a = 17.397\ A$$

Substituting this value in equation

$$2.2 * I_a = 240 - L_{af} * I_a * w$$

$$w = 171.724 \text{ rad/s}$$

From the torque equation, we get

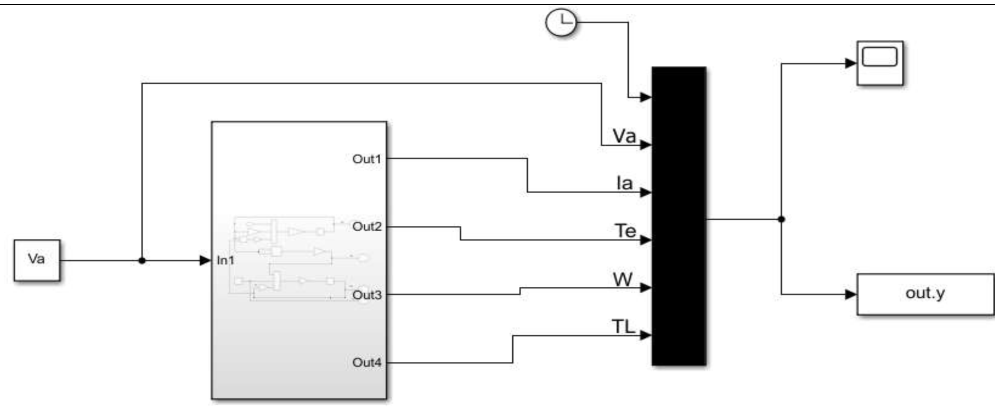
$$T_e = 20.429 \text{ Nm}$$

From the back emf (eb) equation, we get

$$e_b = 201.644 \text{ V}$$

## PROCEDURE FOR SIMULATION STUDY:

1. Write the coding for Initialize the input parameters and as per the requirement of plots in m file and save it.
2. Open new Simulink file and make mathematical modelling as per circuit diagram and save it.
3. Run the m file first, after that run Simulink file.
4. View the result in Scope.
5. Again run m file and view the plots.
6. Make various plots and write the Results.

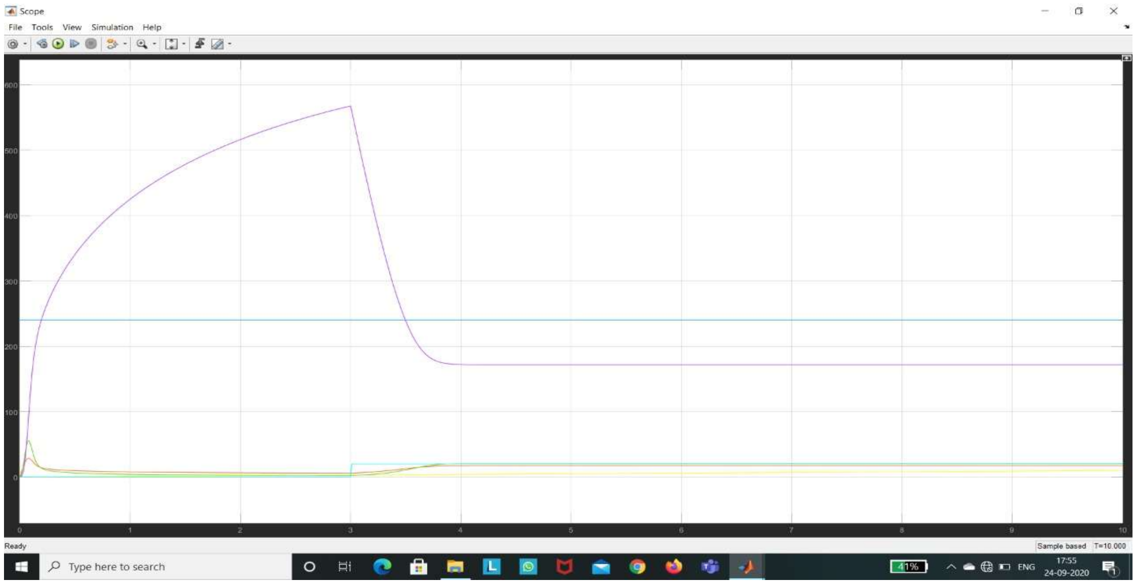


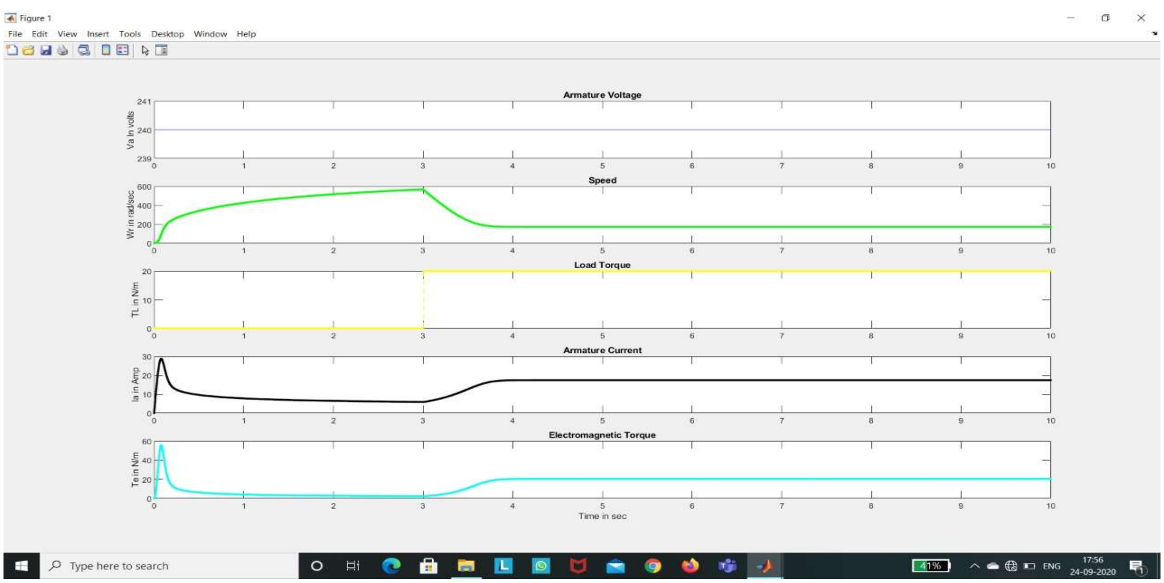

**Mfile code:**

```
Ra=1.5;
La = 0.12;
Lf= 0.3;
Rf= 0.7;
J= 0.02365;
B= 0.0025;
Laf = 0.0675;
Va= 240;
keyboard
subplot(5,1,1)
plot(out.y.signals.values(:,1),out.y.signals.values(:,2),'b-')
title('Armature Voltage')
ylabel('Va In volts')
subplot(5,1,2)
plot(out.y.signals.values(:,1),out.y.signals.values(:,5),'g--.')
title('Speed')
ylabel('Wr in rad/sec')
subplot(5,1,3)
plot(out.y.signals.values(:,1),out.y.signals.values(:,6),'y--.')
title('Load Torque')
ylabel('TL in N/m')
subplot(5,1,4)
plot(out.y.signals.values(:,1),out.y.signals.values(:,3),'k--.')
title('Armature Current')
ylabel('Ia in Amp')
subplot(5,1,5)
plot(out.y.signals.values(:,1),out.y.signals.values(:,4),'c--.')
title('Electromagnetic Torque')
ylabel('Te in N/m')
xlabel('Time in sec')
```

## STIMULATION AND M.FILE CODING:

# RESULTS AND DISCUSSIONS:



## Comparison (Observations)

| Time | Theoretical (current) | Simulation (current) |
|---|---|---|
| **6.301** | **17.42** | **17.41** |

| Time | Theretical (electromagnetic torque) | Simulation (electromagnetic torque) |
|---|---|---|
| **6.893** | **20.41** | **20.41** |

| Time | Theoretical (speed) | Simulation (speed) |
|---|---|---|
| **8.483** | **171.7** | **171.7** |

## Conclusion : The theoretical and experimental values match.

## Inference :

In this motor, field, as well as stator windings, are coupled in series by each other. Accordingly the armature and field current are equivalent. When voltage is applied, current flows from power supply terminals through the series winding and armature winding.

## References