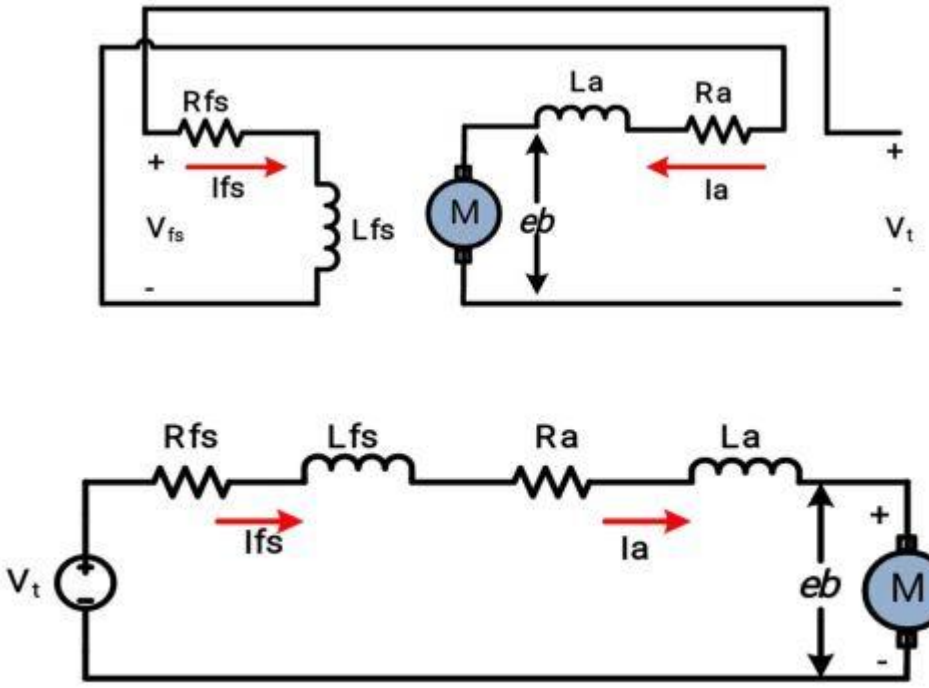
Title of the Exercise: Speed control Series excited DC motor
Date: 13/10/2020
Aim: To obtain speed control characteristic of a Separately excited DC motor.
Tool used : MATLAB and SIMULINK

Electrical Circuit:



Parameters used for the study:

Ra = 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= Source Voltage

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.

Applying Kirchoff's Voltage Law:

Vt = Ifs + Rfs + Lfs * dIfs/dt + IaRa + La * dIa/dt + eb

Value of back emf (eb) is given by

Eb = If * Laf * w

But in series excited DC Motor, Ifs = Ifa + Ia
Eb = Ia * La * w

Electromagnetic torque equation is given by:
Te = Laf * If * Ia
Te = Laf * (Ia) 2

According to torque equation ,
Te = Tl + j(dw/dt) + B*W

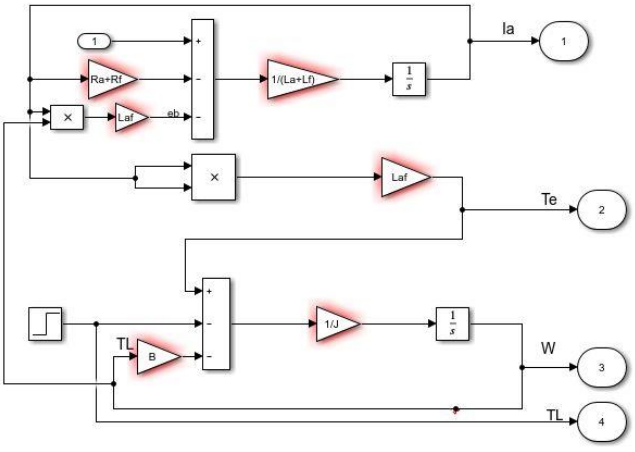
In steady state,
dIa/dt =0 ; dw/dt=0

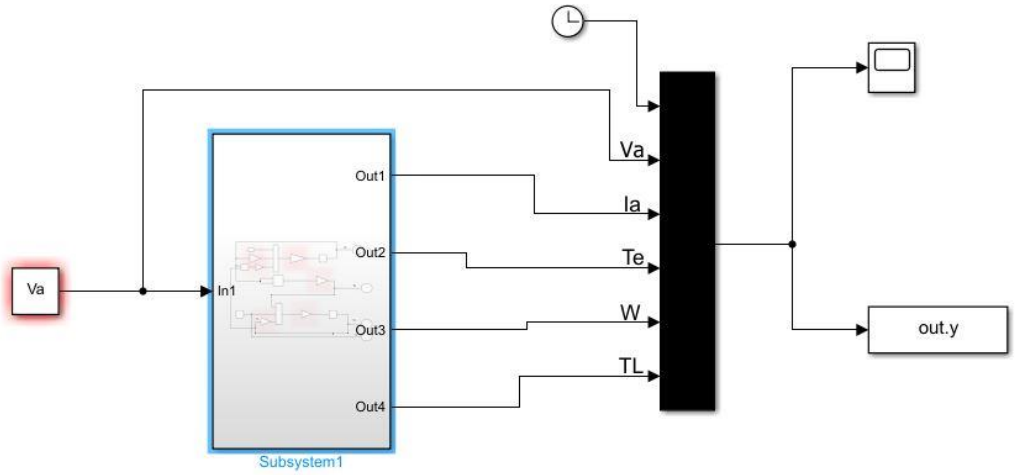
Therefore,
Vt = Ia (Rfs + Ra)
eb = Laf * Ia
Te = Laf * (Ia) ^{2}
Te = Tl + B * w

Procedure:

- Step1-Initialize the input parameters and write coding for the as per requirement of plots in m file and save it
- Step 2-open new Simulink and make mathematical modelling as per circuit diagram and save it
- Step 3-Run the m file first, after that run Simulink file.
- Step 4- Vary the value of load torque T_L from 0 to +20 and then tabulate the corresponding values of armature current, speed and electromagnetic torque.
- Using the 'plot' command in MATLAB, plot the electrical and mechanical characteristics of the DC machine.

Simulink file:





M file for simulation study:

```
Ra=5;
  La = 0.12;
  Lf= 0.3;
  Rf= 0.7;
  J= 0.02365;
  B= 0.0025;
  Laf = 0.0675;
  Va= 230;
  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')
```

M file for obtaining the characteristics:

For Ra control:

```
a =[ 355.505 5.81
    254.947 10.6449
    209.274 15.523
    179.099 20.447];
b=[341.804 5.853
    243.610 10.609
    194.735 15.486
    164.486 20.4112];
c=[300.758 5.750
    200.613 10.501
    151.213 15.378
    120.575 20.301];
plot(a(:,2),a(:,1))
hold on
plot(b(:,2),b(:,1))
hold on
plot(c(:,2),c(:,1))
```

For Va control:

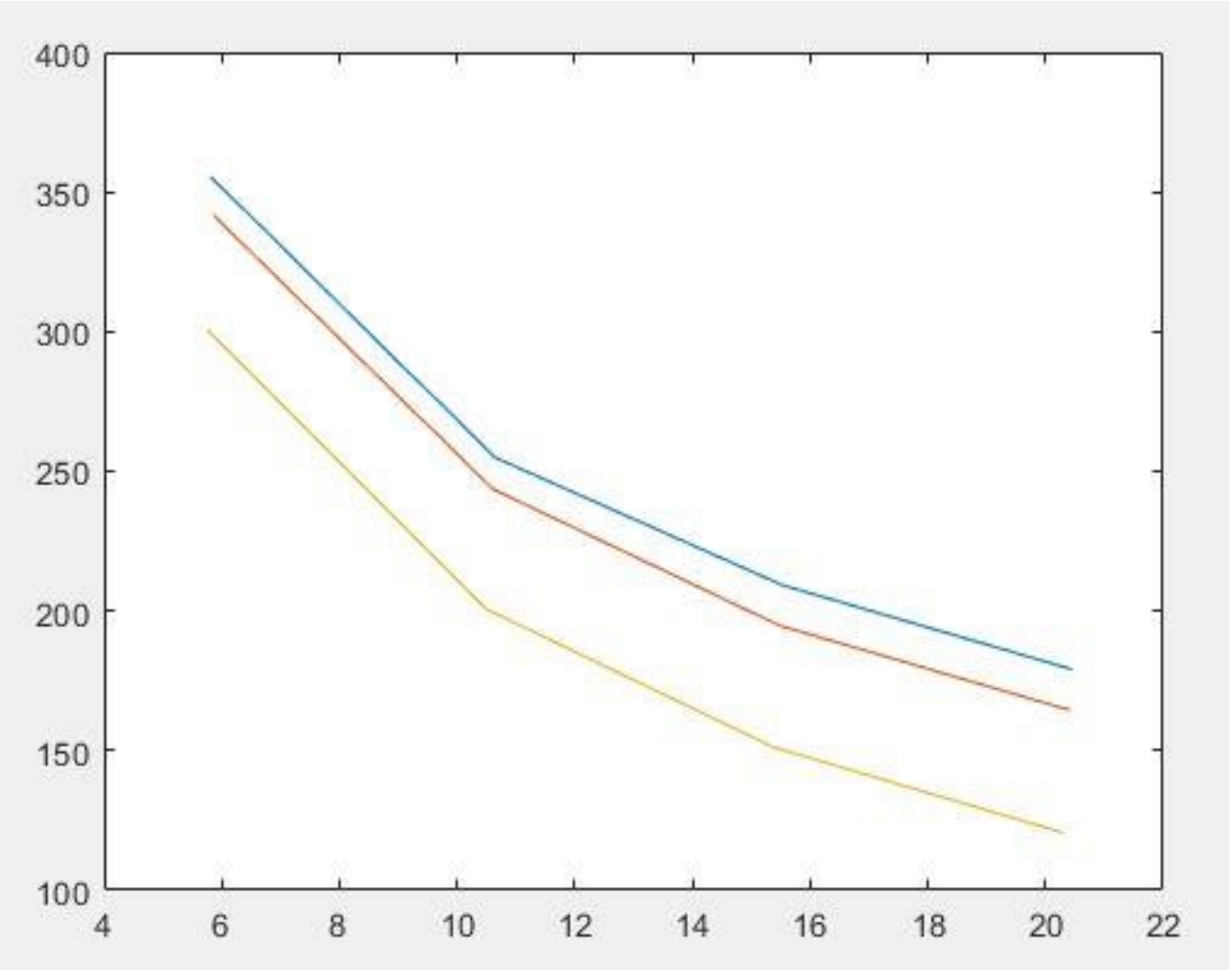
```
a =[225.924 5.639
    166.014 10.415
    122.162 15.305
    95.228 20.338];
b=[270.955 5.678
    177.578 10.443
    131.830 15.329
    103.686 20.259];
c=[285.899 5.714
    189.110 10.472
    141.483 15.353
    112.135 20.803];
plot(a(:,2),a(:,1))
hold on
plot(b(:,2),b(:,1))
hold on
plot(c(:,2),c(:,1))
```

Results and Discussions:

CHARACTERISTICS:

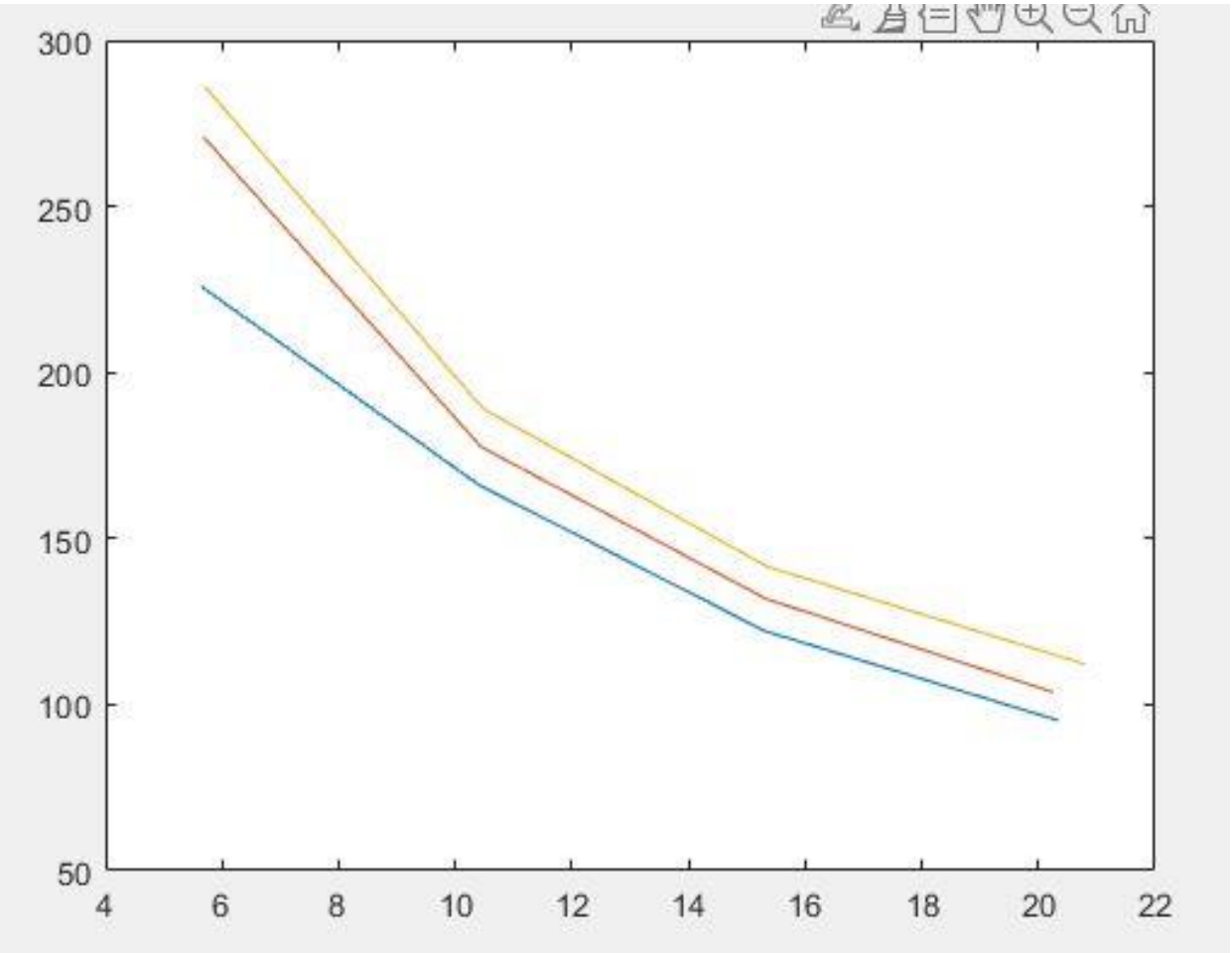
For Ra control:

W vs Te graph for ra=1,2,5



For Va control:

W vs te graph for va=210,220,230



Observations:

Separately Excited DC motor:

Positive load torque (simulation values)

For Ra control:

Ra = 1ohm

Tl	W	Te
5	355.505	5.81

10	254.947	10.6449
15	209.274	15.523
20	179.099	20.447

Ra = 2 ohm

Tl	W	Te
5	341.804	5.853
10	243.610	10.609
15	194.735	15.486
20	164.486	20.4112

Ra = 5 ohm

Tl	W	Te
5	300.758	5.750
10	200.613	10.501
15	151.213	15.378
20	120.575	20.301

For Va control:

Va = 210

Tl	W	Te
5	225.924	5.639
10	166.014	10.415
15	122.162	15.305
20	95.228	20.338

Va = 220

Tl	W	Te
5	270.955	5.678
10	177.578	10.443
15	131.830	15.329
20	103.686	20.259

Va = 230

Tl	W	Te
5	285.899	5.714
10	189.110	10.472
15	141.483	15.353
20	112.135	20.803

Conclusion:

Hence, the speed control characteristics of a series excited DC Motor have been obtained for different values of Load torque.

Inference:

The speed control characteristics of a separately excited DC motor give the variation of:
Speed vs electromagnetic torque

References

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