MSS Lab	Prof. Dr.-Ing. G.Schmitz
Part A: Lumped Element Simulation (Saber) **Exercise 7: Control Domain Models**	**Flugzeug- Elektrik und Elektronik**

Last Name	First Name	Matr.-Nr.

Date	Confirmation (Testat)

FH AACHEN
UNIVERSITY OF APPLIED SCIENCES

1 Introduction

In this lab the use of the control domain should be learned. As an example we take again the well-known Permanent Magnet Motor. The control domain in Saber is similar to the simulations with Simulink. The values have no units, there are only "across" variables, you don't have to use a ground node since all "across values" are with reference to ground".

2 Execution of the exercises

2.1 Simulation comparing the model in the control domain and in the electrical/mechanical domain

### 2.1.1 Setting up the motor model in the control domain

The model for a Permanent Magnet DC-Motor is shown in the following figure. For the simulation you should take the following parameters for the motor (the inductance L should be neglected (later in the Saber motor model DC_PM2 you can set it to e.g. 1pH since it is a required parameter)

The model

Meaning	Sabername	suggested value	Unit
Motor inertia J	j	10u	kgm^2
Torque constant k$_T$	kt	5m	Nm/A
Back EMF constant k$_e$	ke	5m	V/rad/s
Armature winding inductance L$_A$	laa	1p	H
Armature winding resistance R$_A$	ra	100m	Ω
Motor viscous damping constant d	dzi	5u	Nm/rad/s

For the control source you can take the parameters:

initial value: 0, pulse: 1, width: 2 (seconds)
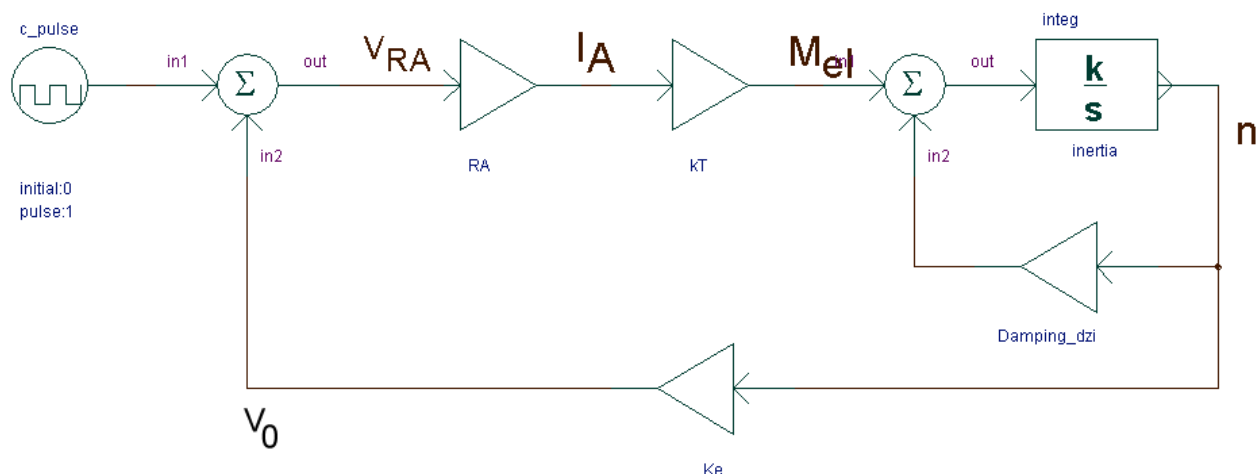
Short explanation of the model:

The control source may be regarded as an ideal voltage source with a short pulse of 1Volt for a duration of 2 seconds as a supply voltage for the motor. The voltage is given to the motor where the voltage difference V_{RA} between this supply voltage and the magnet wheel voltage V_0 is available for driving a current through the Armature resistance R_A. The resulting current I_A will generate a torque M_{el} which is proportional to the current with a proportionality constant k_T.

The Motor damping which is proportional to the motor speed with the proportionality constant d_{zi} reduces the torque which is available for accelerating the motor. The acceleration will be proportional to the resulting torque which has to overcome the inertia of the motor which is modeled as an integrator, delivering the motor speed n (in rad/s).

The resulting speed n will now be converted with the factor k_e to the back EMF, i.e. magnet wheel voltage V_0 which is fed back to the summation point on the left hand side.

You have to feed in now the parameters given above in the correct way to the parameters of the control domain models.

Then start a simulation for a simulation time of e.g. 10s and try to think about the plausibility of the results.

2.1.2 Conventional motor model

Now conduct the same simulation with the readily available motor model DC_PM2, which you know from Exercise 5.

This time you should directly connect the motor to a voltage pulse source with the same parameters as in the control domain pulse source.
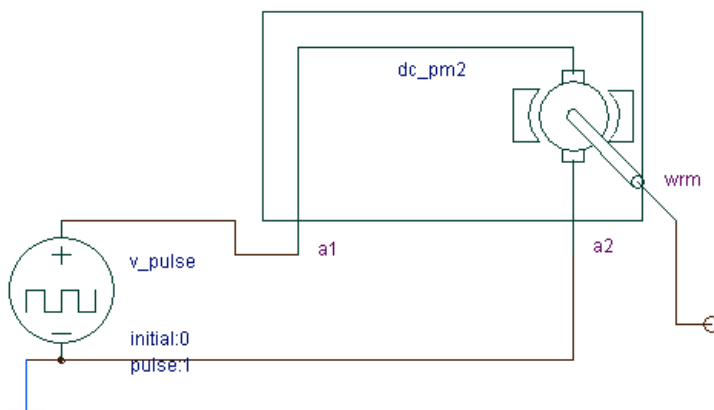
Compare the results you get for the simulation to the result of the control domain model.

2.2 Modification of the model

Compared to our experiments in Exercise 5 the behavior of the motors is different for the switch off phase. We have here now the situation that the Voltage at the clamps of the motor is zero in the switched off state while using the circuits in Ex5 we had just a switching off of the transistor so that no (negative) current could flow through the motor after the switch off.

Try to find an amendment for both models in this exercise so that the switch off behavior again is similar to the one from Ex5 – except the fact that due to the different kind of friction in task 5 we have a linear drop of the speed while we face here an exponential drop.

2.3 Extension of the model

In Ex5 we had connected a second motor which could be used as an external Tacho-generator and we had connected an external load (also the Tacho-generator could be used as an external load by connecting a resistor to the electrical terminals).

How could the model of task 2.1.1 (control domain) be modified or amended to be able to connect a second motor and/or an external load to the first motor.

Next please figure out if there is a simple way to have two identical motor models connected to each other obtaining the correct behavior.

Maybe you can draw a conclusion for the comparison of Simulink and Saber based on your considerations.