Laboratory "Modeling and Simulation of Dynamic Systems"
Institute of the Theory of Electrical Engineering, Measurement and Information Systems, WUT

Exercise No 3A
SHUNT DC MOTOR
Author: S. Osowski

1 Introduction

We apply the linear model of DC shunt motor, of separately excited DC excitation producing the constant excitation flux ϕ. It is expressed in the following state space form

$$\left[\begin{array}{c} \frac{di}{dt} \\ \frac{d\Omega}{dt} \end{array}\right] = \left[\begin{array}{cc} -\frac{1}{T_t} & -\frac{J}{T_m T_t C_m \phi} \\ \frac{R_t}{T_m C_e \phi} & 0 \end{array}\right] \left[\begin{array}{c} i \\ \Omega \end{array}\right] + \left[\begin{array}{cc} \frac{1}{R_t T_t} & 0 \\ 0 & -\frac{1}{J} \end{array}\right] \left[\begin{array}{c} U \\ M_z \end{array}\right] \tag{1}$$

The torque produced by the motor is given by

$$M_n = C_m \phi i \tag{2}$$

At constant ϕ it is proportional to the current i. Fig. 1 illustrates the Simulink model of the motor state space equation. For the particular motor of the nominal power $P = 22kW$ and nominal torque $M = 140.1Nm$ the state

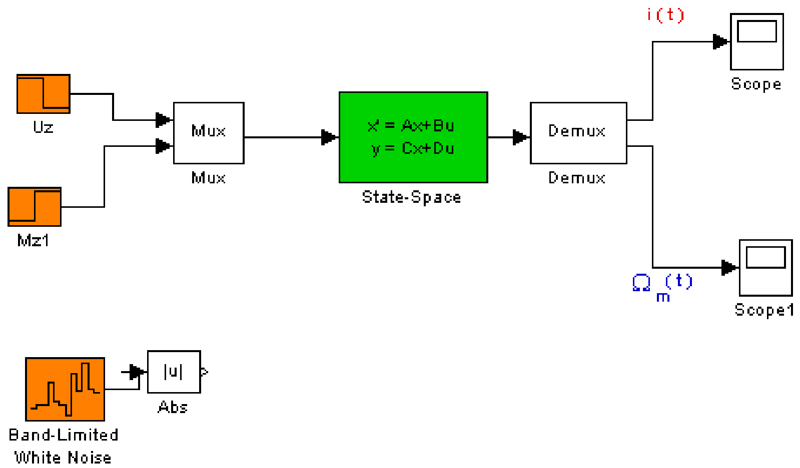

Figure 1: *Simulink model of DC shunt motor at "active" load*

space parameters are as follows

$$\mathbf{A} = \left[\begin{array}{cc} -30.3 & -170.74 \\ 0.97 & 0 \end{array}\right], \quad \mathbf{B} = \left[\begin{array}{cc} 65.168 & 0 \\ 0 & -0.37 \end{array}\right] \tag{3}$$

This model is limited to the so called "active" load. In the case of true "passive" load the model should be completed with some additional nonlinear elements. One of the possible solution is presented in Fig. 2 (the file **sil_st2.mdl**). This model enables to perform the numerical experiments at any mode of operation and at any load of passive character.

2 Program of experiments

In the experiments we will investigate both models. The first one is suited for "active" load nad the second for "passive" one. If the start of the engine is at no load, or the load torque is not higher than the actually generated electromagnetic torque, the results of both models should be identical. In the simulation program the following modes of the motor work should be considered:

1. start of the motor at $M_z = 0$ i $M_z \neq 0$
2. change of the load torque M_z for the running motor at constant supply voltage (for example M_z equal $0.5M_n$, $1.5M_n$, $5M_n$,
3. reverse of the motor at $M_z = 0$ i $M_z \neq 0$

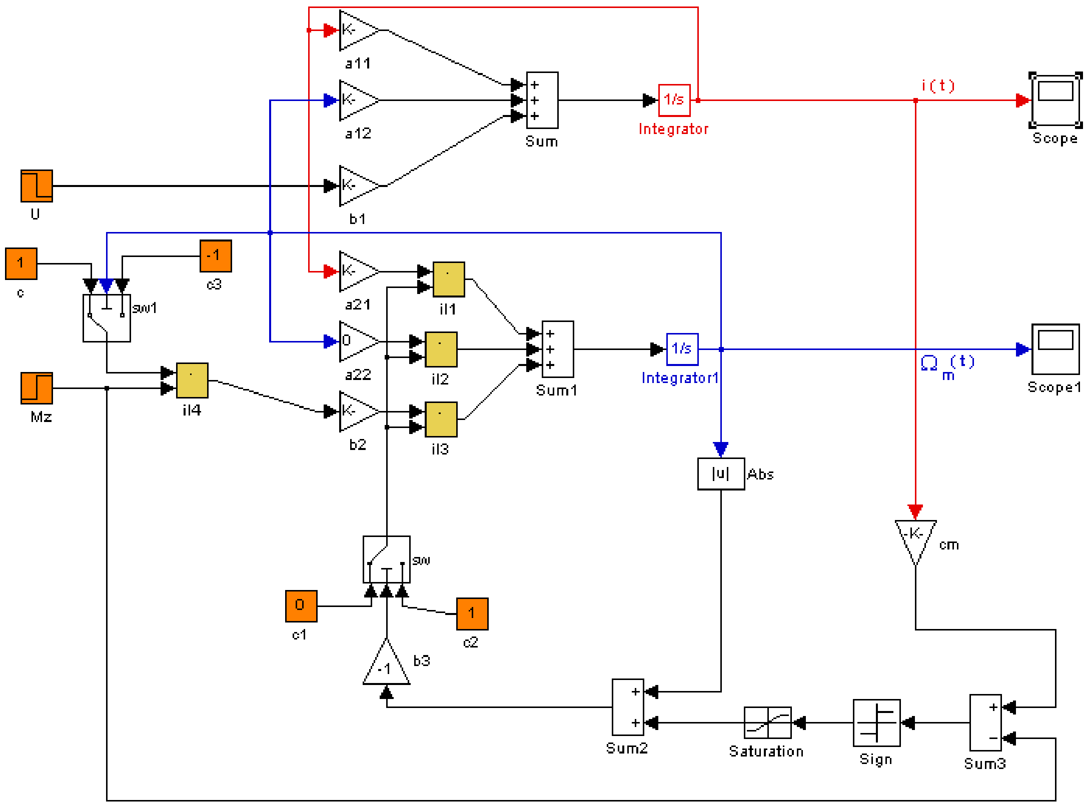

Figure 2: *Simulink model of DC shunt motor at "passive" load*

4. change of the supply voltage at $M_z = 0$ and nonzero $M_z = const$
5. change the supply voltage to zero (electromagnetic breaking) at $M_z = 0$ and nonzero $M_z = const$

All transient results should concentrate on the change of the current i_t (the torque is proportional to current) and on the mechanical revolutions Ω.