Lab 2. DC MOTOR DRIVE MODELLING

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Specialization: Automation

Objective

To get acquainted with modelling of speed/torque characteristic, of braking modes and of speed control of the DC motor in the Simulink software environment.

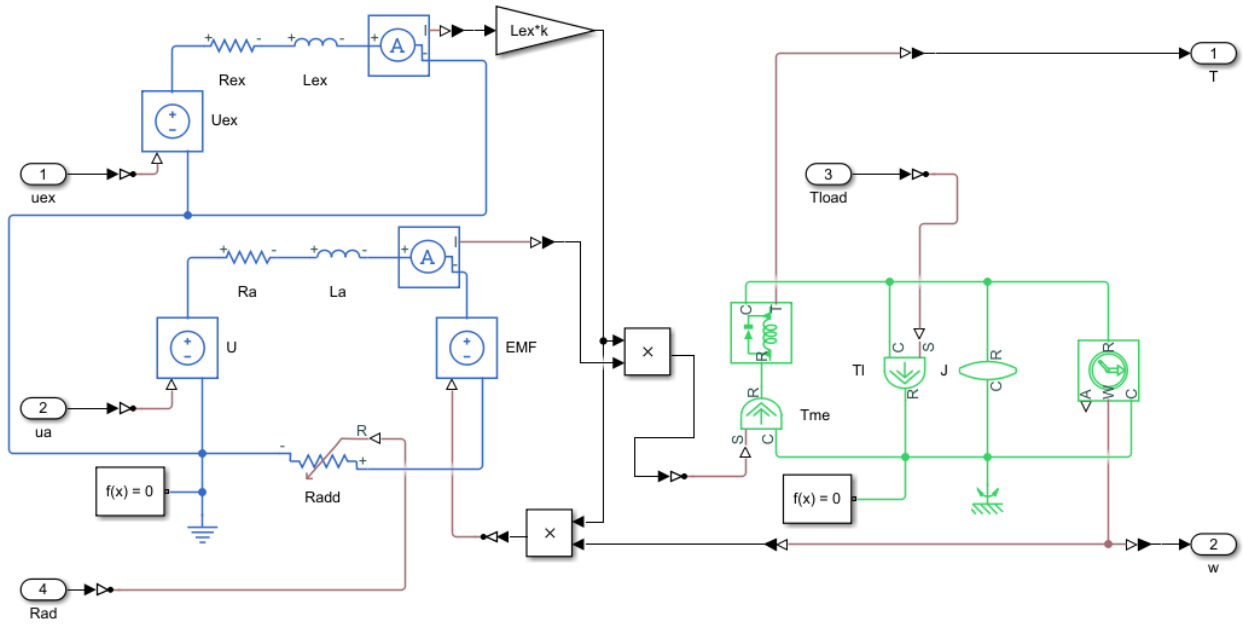

Figure 1. Simulation scheme of the electromechanical system DC motor – mechanical load.

Initial data

Parameter	R_a	L_a	R_{ex}	L_{ex}	I_{amax}	k	J	T_{load}
Value	9.411 Ohm	32.5 mH	0.9378 Ohm	229.3 mH	9 A	0.0624	10.27 $kg \cdot m^2$	2.1 Nm

1. Build a simulation circuit.

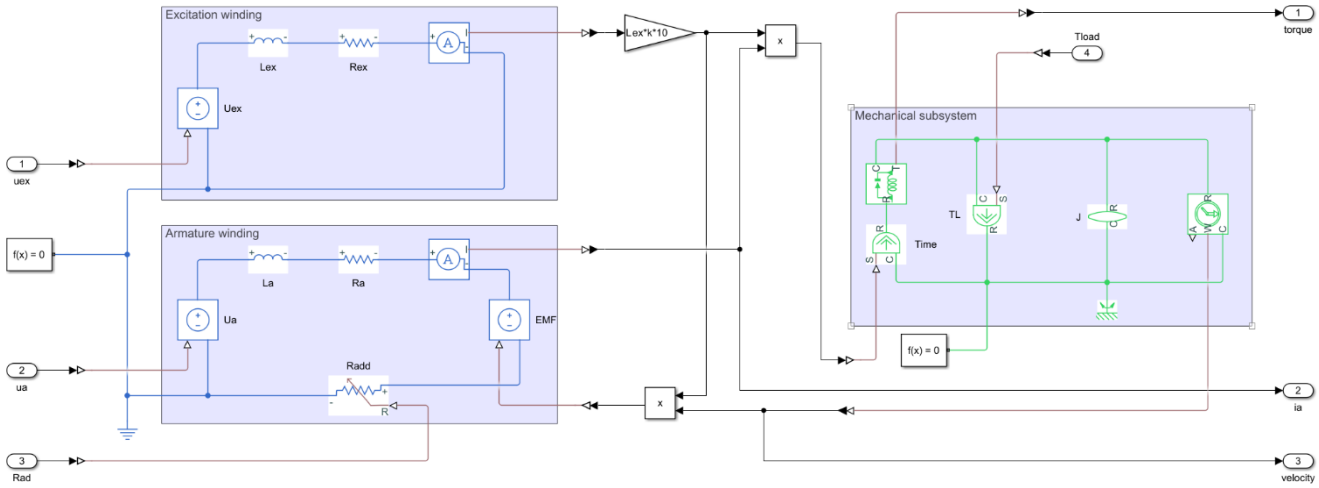

Figure 2. Simulation circuit.

2. Simulation of natural and artificial speed/torque characteristics of DC motor.

a. Speed control of the DC motor by changing armature voltage (U_{nom}, $0.8U_{nom}$, $0.6U_{nom}$, $0.4U_{nom}$, $0.2U_{nom}$).

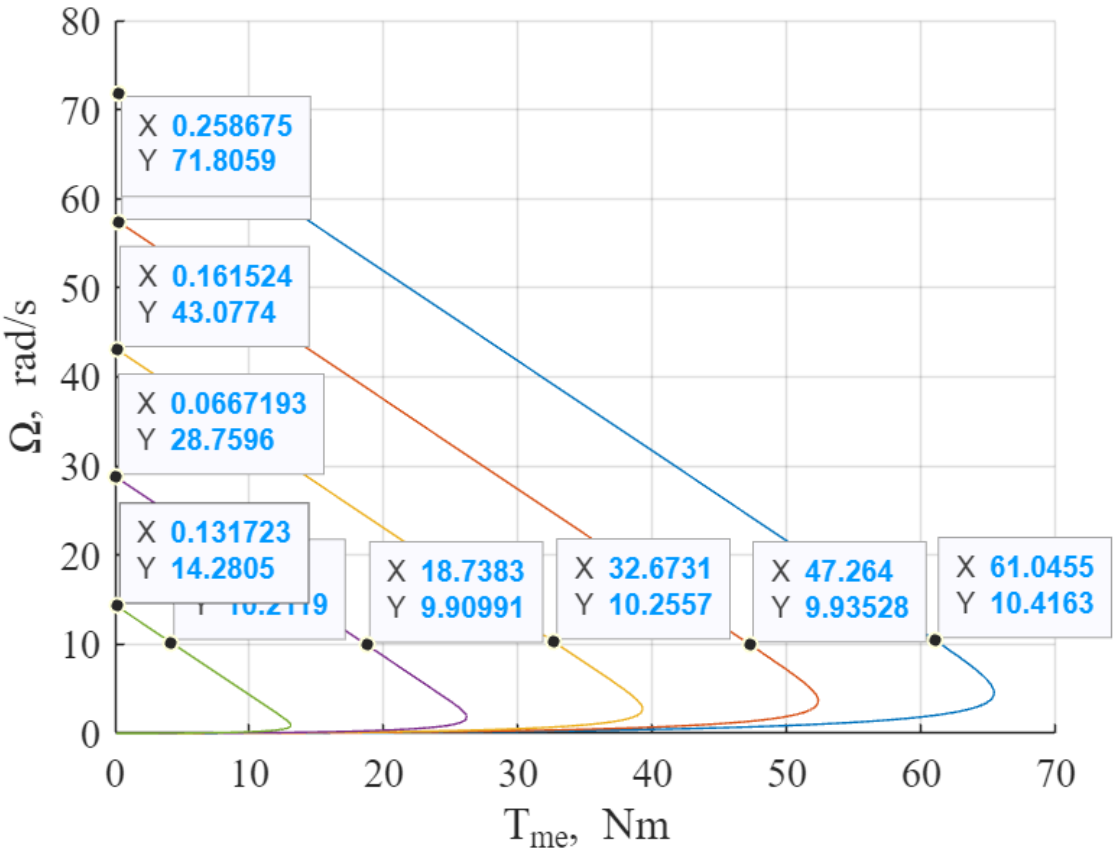

Figure 3. Speed control of the DC motor by changing armature voltage.

b. Speed control of the DC motor by changing the magnetic flux (U_{ex}, $0.8U_{ex}$, $0.6U_{ex}$, $0.4U_{ex}$, $0.2U_{ex}$).

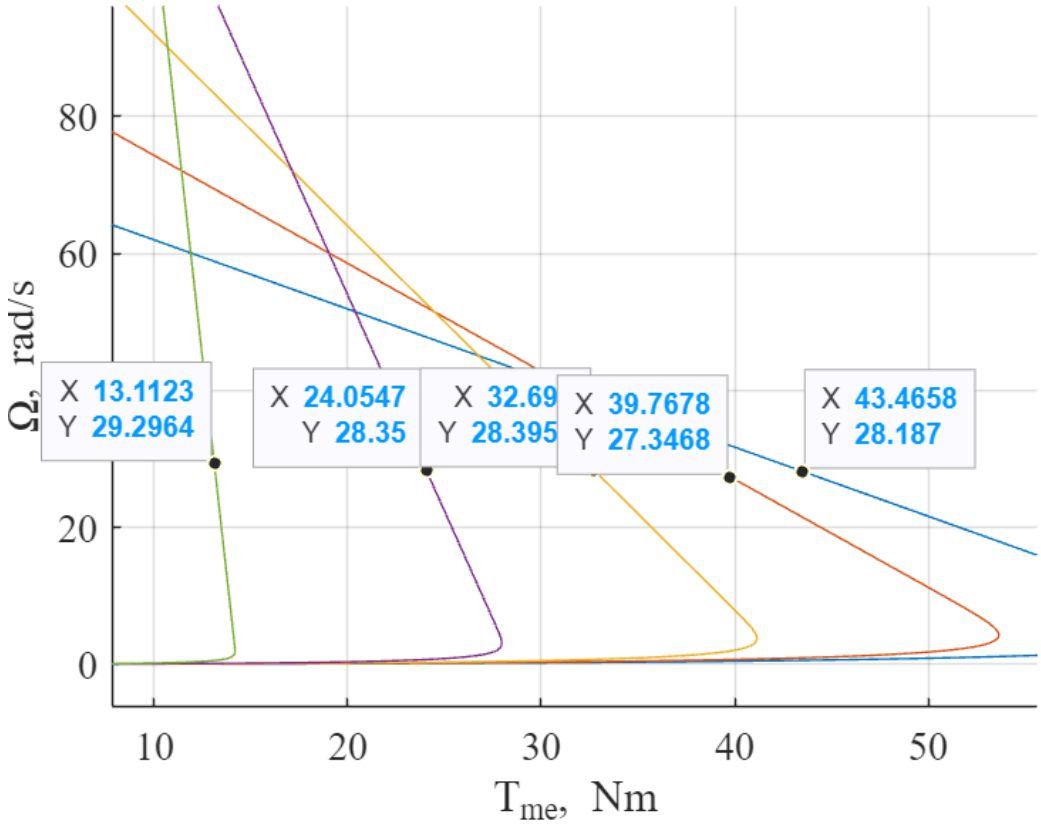

Figure 4. Speed control of the DC motor by changing the magnetic flux.

3. Simulation of braking modes.

a. Simulation of reverse braking by adding resistance R_{add}.

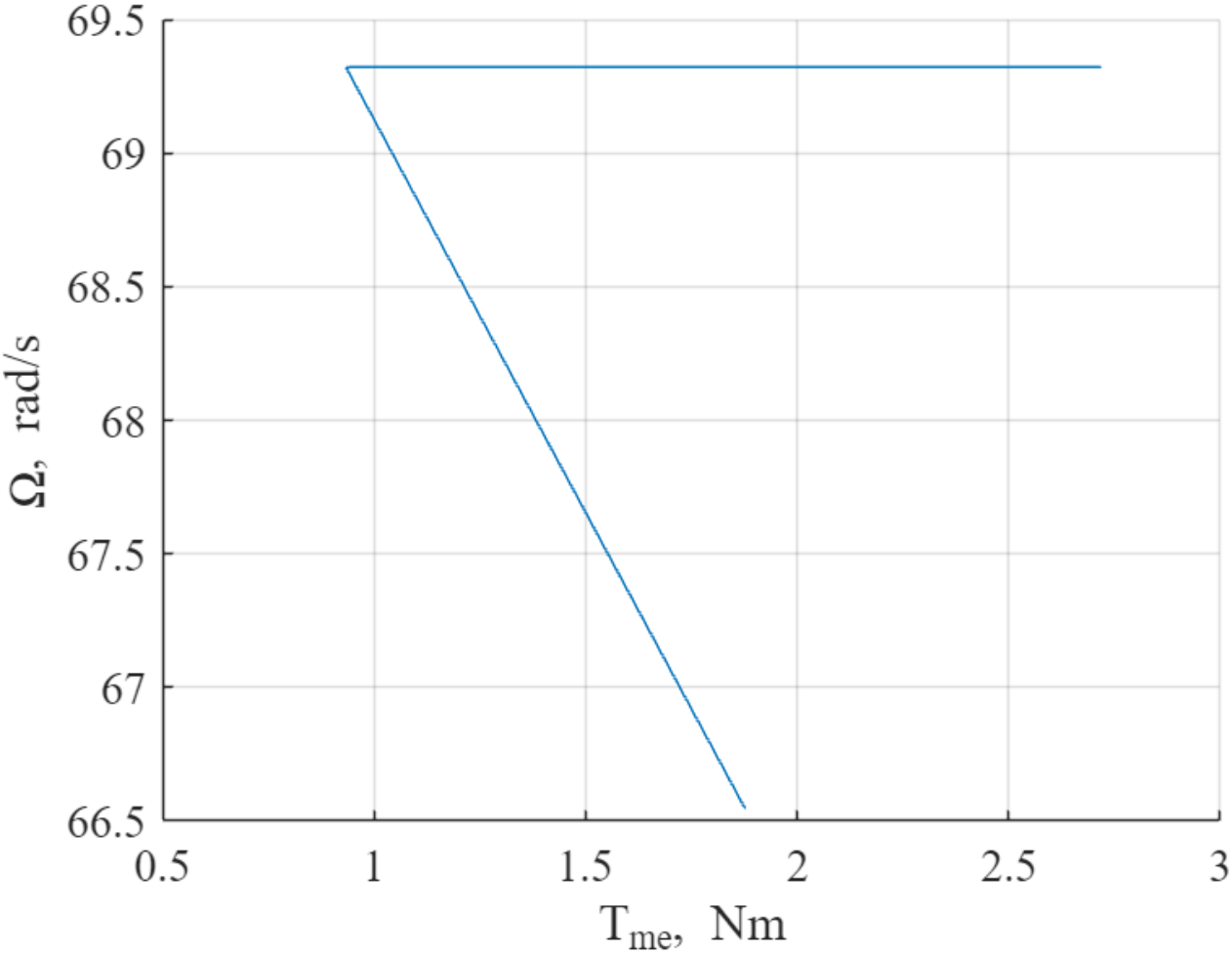

Figure 5. Reverse braking.

b. Simulation of dynamic braking by disconnecting converter and connecting resistance Radd.

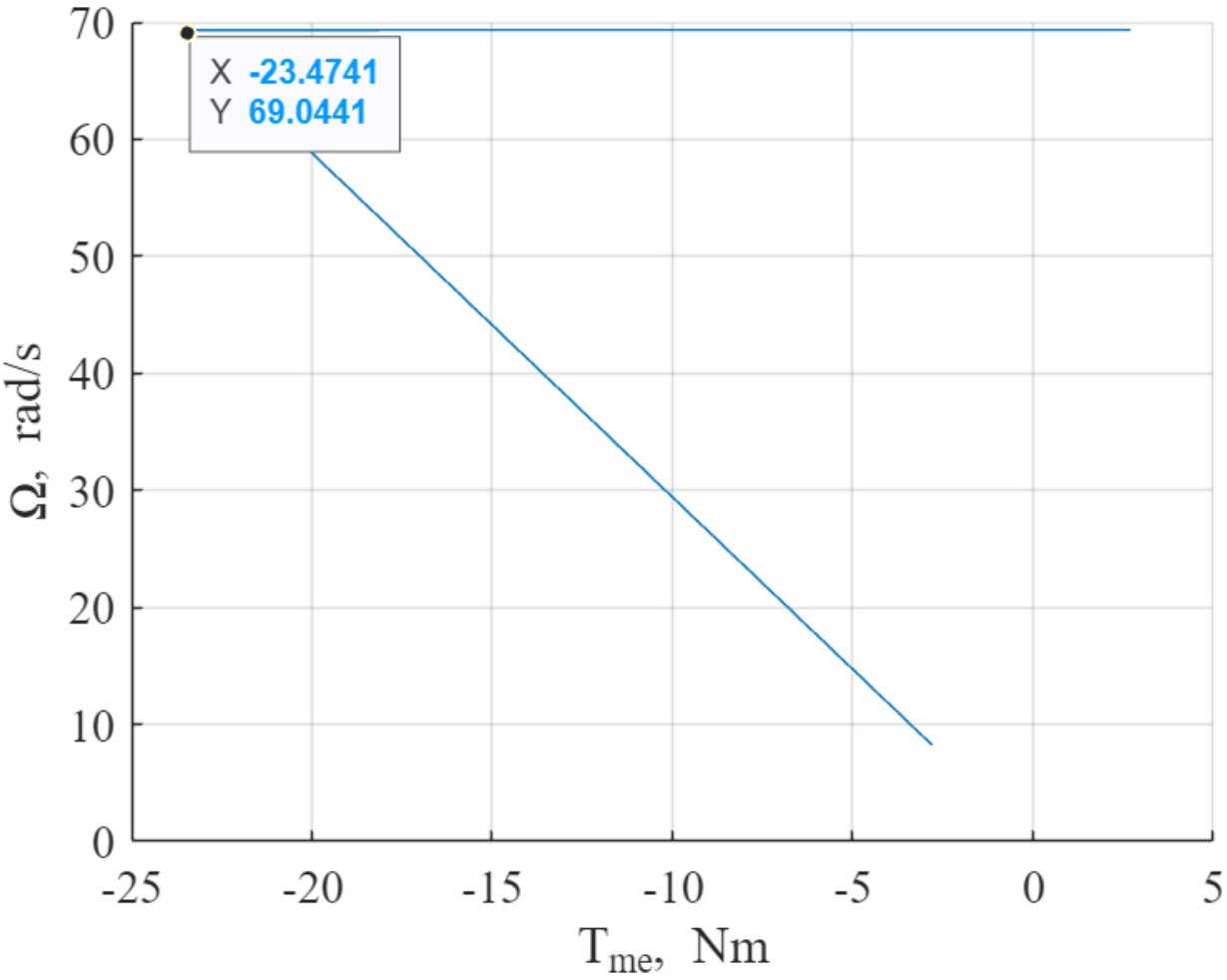

Figure 6. Dynamic braking.

c. Simulation of regenerative braking by changing armature voltage from Unom to 0.8Unom.

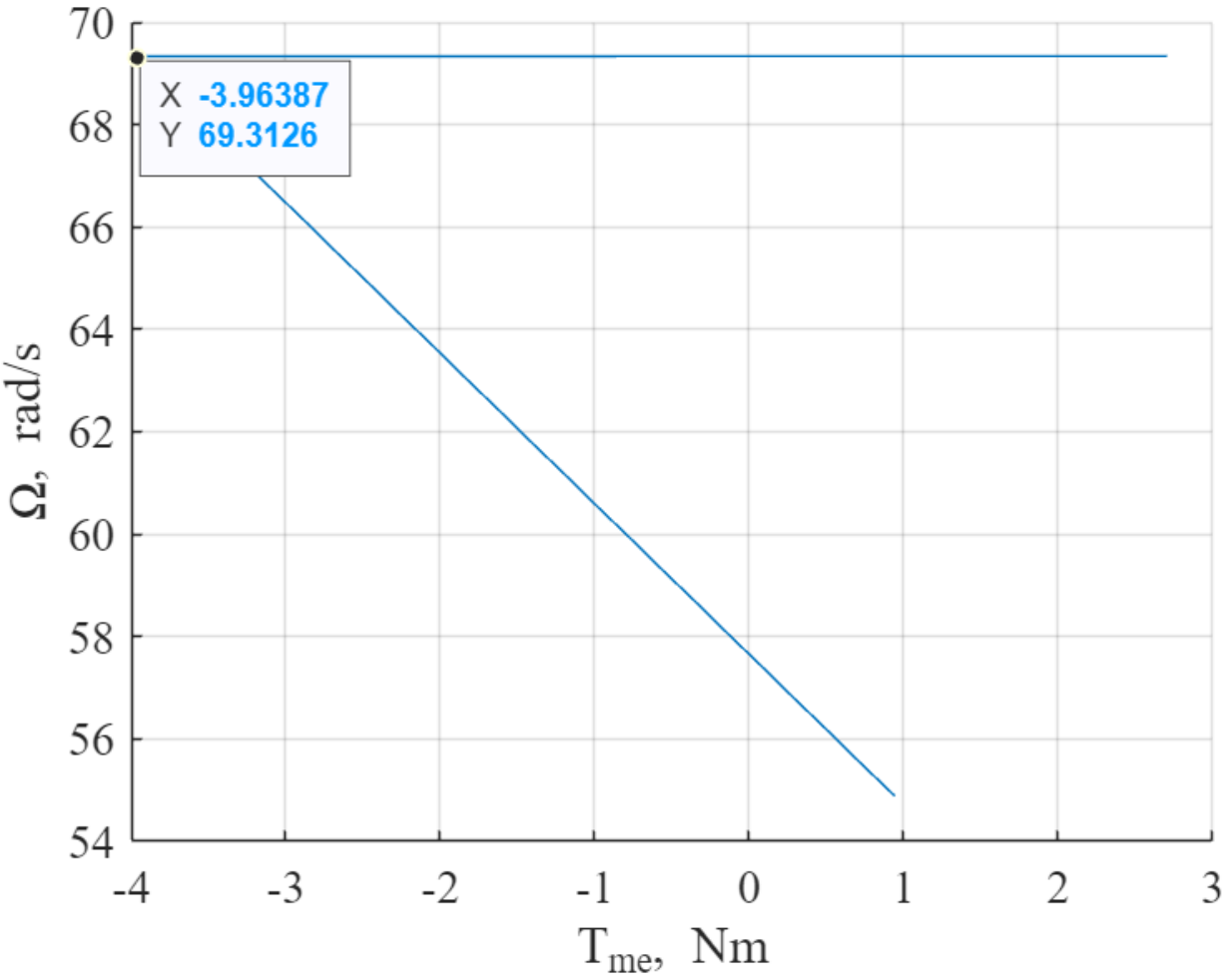

Figure 7. Regenerative braking.

4. Simulation of starting of the DC motor.

a. Simulation of direct starting of the DC motor.

I_{inr} = 22.8 A > I_{max}

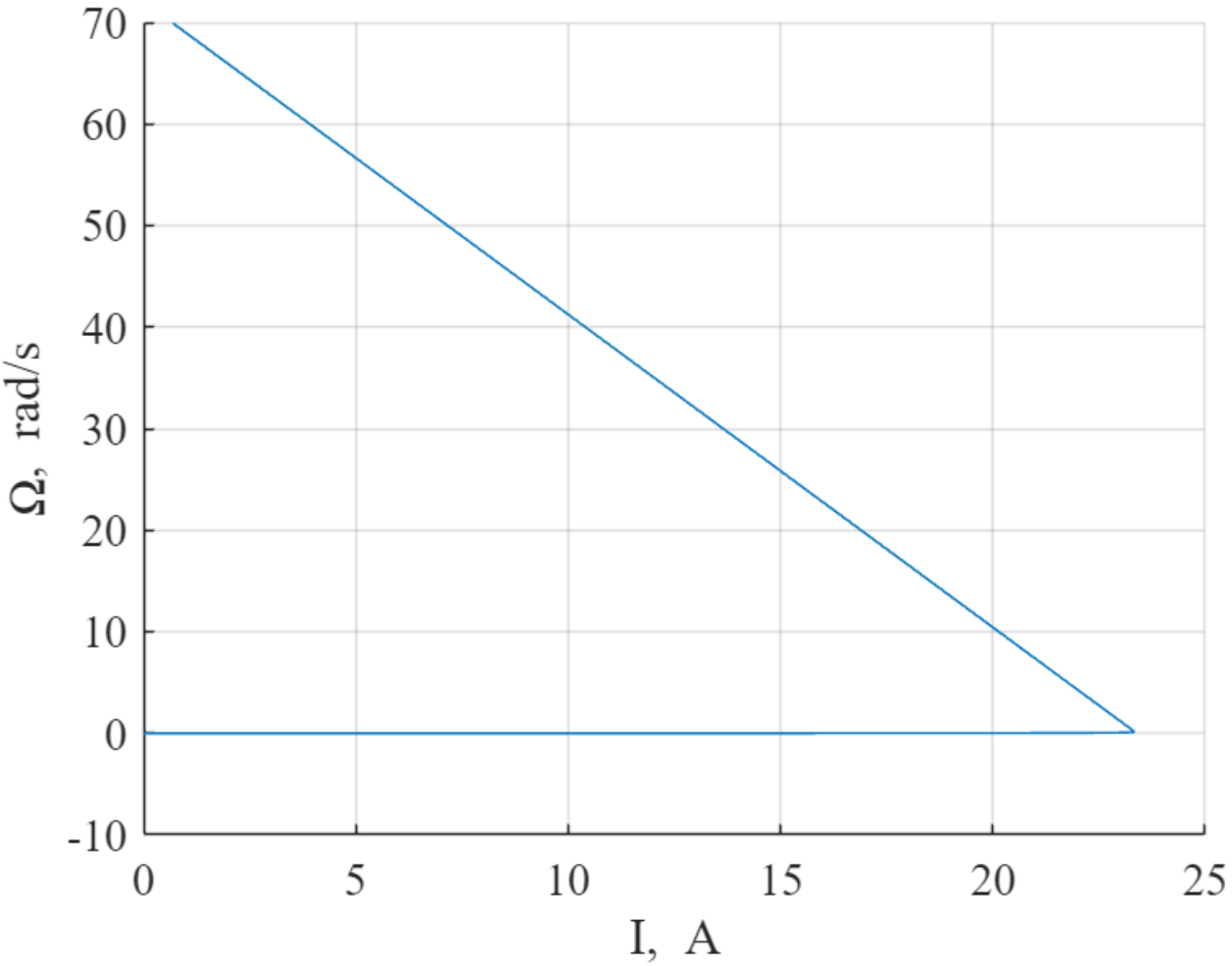

Figure 8. Direct starting of the DC motor.

b. Simulation of starting of the DC motor with additional resistances R_1, R_2, R_3. Armature current I_a must be lesser then maximum value I_{amax}.

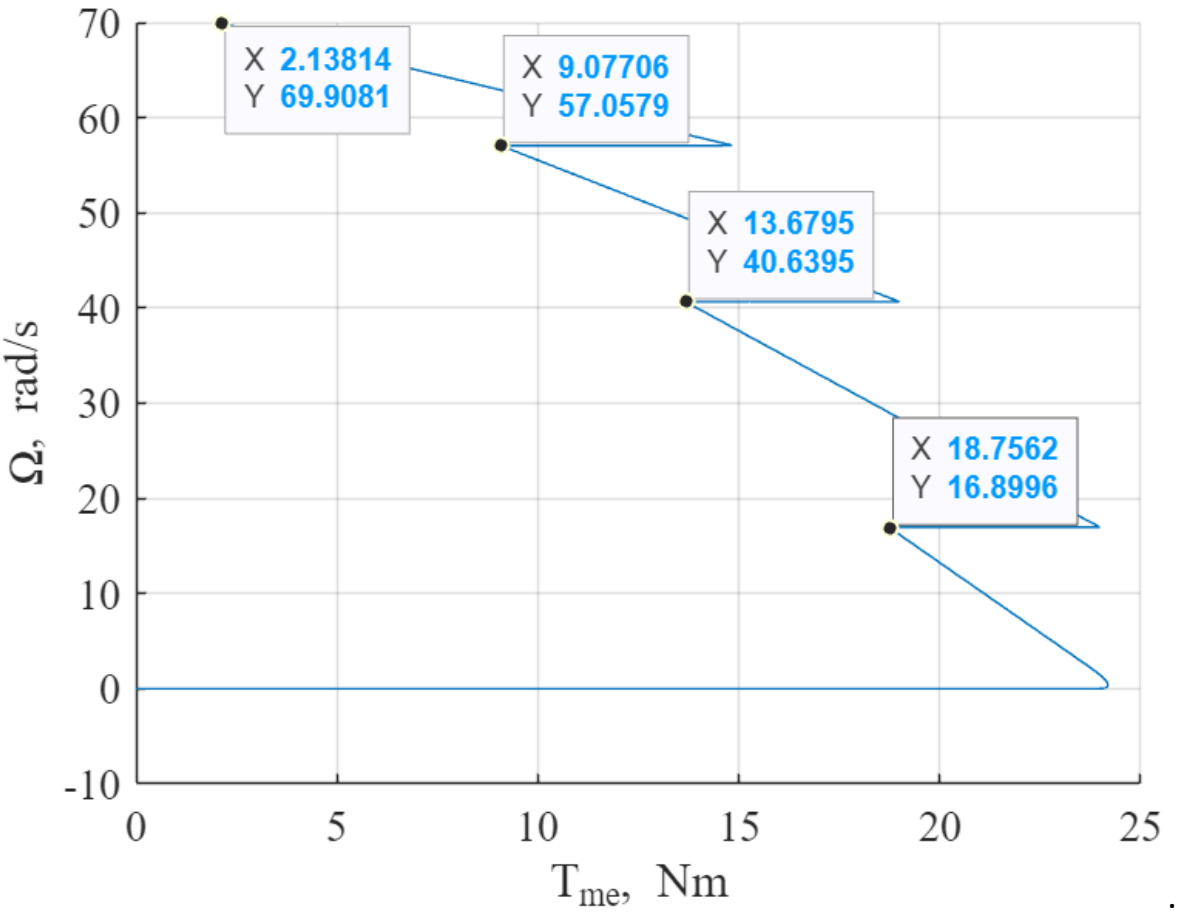

Figure 8. Starting of the DC motor with additional resistances.

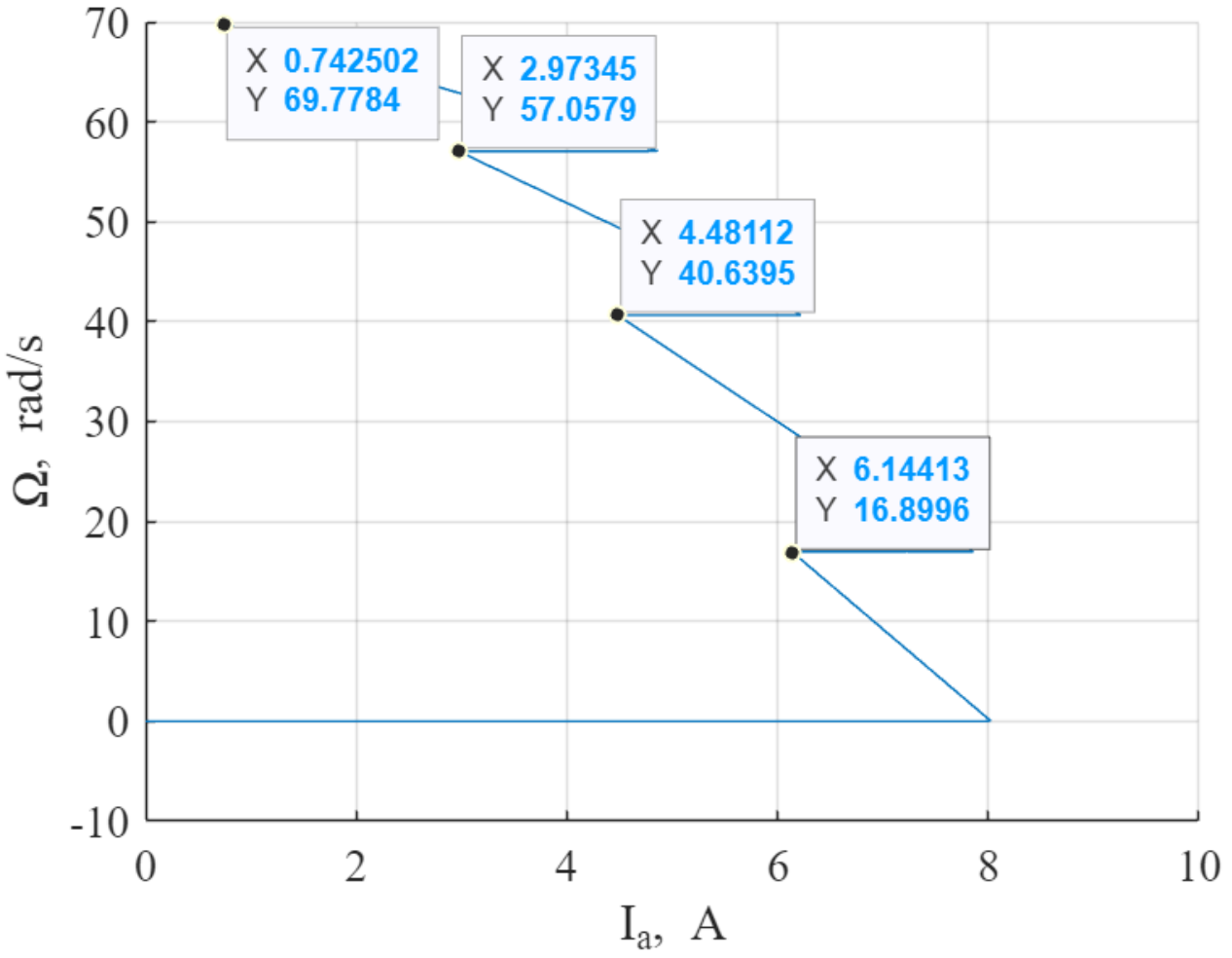

Figure 9. Starting of the DC motor with additional resistances (speed/current).

Conclusion:

In this lab, I modeled a DC motor in Simulink, analyzing speed/torque characteristics, speed control, braking modes, and starting methods. Speed control was achieved by varying armature voltage and magnetic flux, confirming theoretical relationships. Three braking modes—reverse, dynamic, and regenerative—were simulated, with regenerative braking being the most energy-efficient. Direct starting caused high inrush current, mitigated by adding resistances to limit current. The simulations validated theoretical principles and demonstrated practical control strategies for DC motor operation, highlighting the importance of safe and efficient motor management.