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

Exercise No 5A

MODELING OF DYNAMICS OF THE STEPPING MOTOR

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1. The aim of experiments

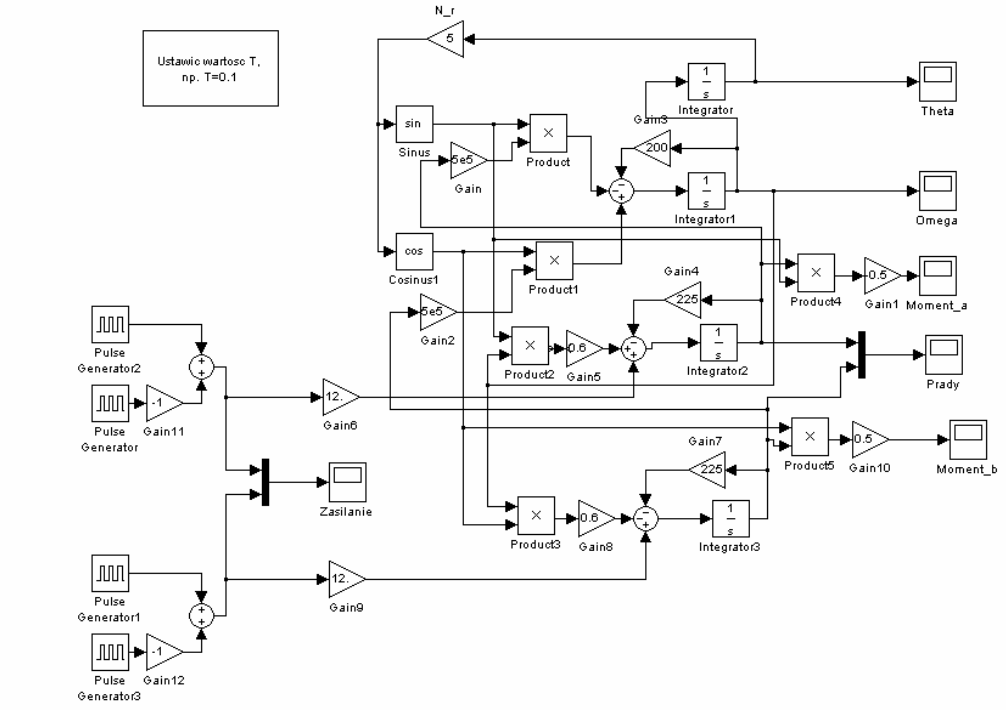
Learning the dynamic properties of the stepping motor.

2. The mathematical model

The equations describing the dynamics of the two-phase stepping motor of the permanent magnet are given in the form:

$$\begin{aligned}
\frac{d\theta}{dt} &= \omega \\
\frac{d\omega}{dt} &= -\frac{K_b}{J} i_a \sin(N_r\theta) + \frac{K_b}{J} i_b \cos(N_r\theta) - \frac{B}{J}\omega \\
\frac{di_a}{dt} &= -\frac{R}{L} i_a + \frac{K_b}{L}\omega\sin(N_r\theta) + \frac{1}{L} v_a \\
\frac{di_b}{dt} &= -\frac{R}{L} i_b - \frac{K_b}{L}\omega\cos(N_r\theta) + \frac{1}{L} v_b
\end{aligned} \tag{1}$$

where: θ – rotating angle, ω – angle speed, i_a, i_b – the phase currents of the motor, J - rotor inertia, B – coefficient of the friction, R – resistance of the stator, L – inductance of the stator, N_r – number of rotor teeth, $K_b=N_r\psi_{max}$ – the coefficient of the emf, ψ_{max} – the maximum value of the flux linkage. Fig. 1 presents the Simulink model of the state space equations describing the stepping motor (the file **silnik_krokowy.mdl)**.



Rys. 1 Simulink model of the two-phase stepping motor

3. Program of numerical experiments

The experiments will be directed to the observation of transient state of the currents in both phases, the mechanical torque generated by the motor, the angle speed and the rotation angle at 2 different frequencies of the

supply voltage. The supply voltage of both phases is of the square form, shifted in a proper way (see the supplying waveform on the scope).
Run the simulation at the following parameters of the system:

- The period of the supply voltage T=0.1 and T=0.2
- The rotor inertia $J=J_n$ and $J=5J_n$.
- The friction coefficient $B=B_n$ and $B=0.2B_n$

To change these parameters it is enough to introduce the proper scaling coefficient in the appropriate equations.