Lab 6. Basic control action in dynamic systems

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Specialization: Automation

Objective

To get acquainted with the principles of synthesis of control systems for technical systems in the Simulink software environment.

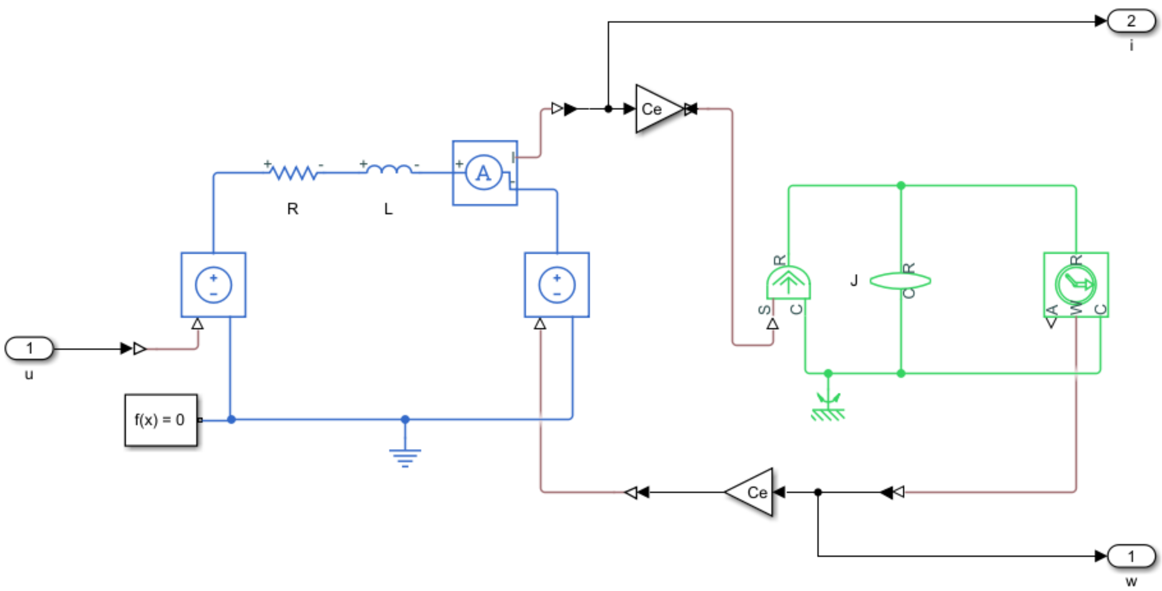

Figure 1. Simulation scheme of the electromechanical system DC motor – mechanical load.

Initial data

Parameter	R	L	C_e	J	τ
Value	1.9713 Ohms	0.0169 H	1.9964 V*s/rad	0.9241 kg*m^2	0.0086 s

1. Build a simulation circuit.

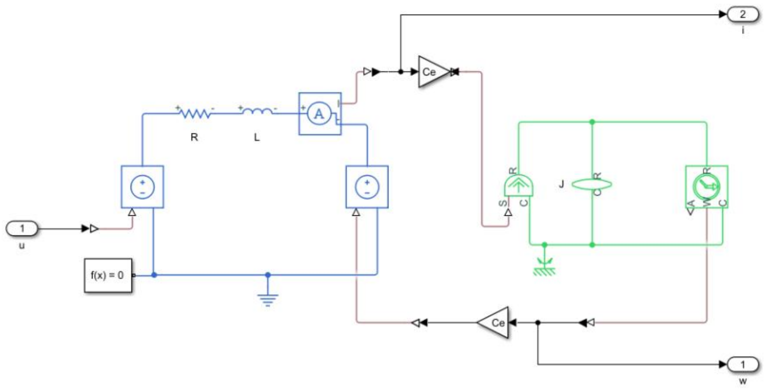

Figure 2. Simulation circuit.

2. Calculate the transfer function of the control object from the control signal to the controlled coordinate (speed).

$$\frac{di_L}{dt} = -\frac{R}{L} i_L - \frac{C_e}{L}\omega + \frac{u}{L}$$
$$\frac{d\omega}{dt} = \frac{C_m}{J} i_L$$

$$s \cdot i_L = -\frac{R}{L} i_L - \frac{C_e}{L}\omega + \frac{u}{L}$$
$$s \cdot \omega = \frac{C_m}{J} i_L$$

$$i_L = \frac{J \cdot s}{JL \cdot s^2 + RJ \cdot s + C_m C_e} u$$
$$\omega = \frac{C_m}{JL \cdot s^2 + RJ \cdot s + C_m C_e} u$$

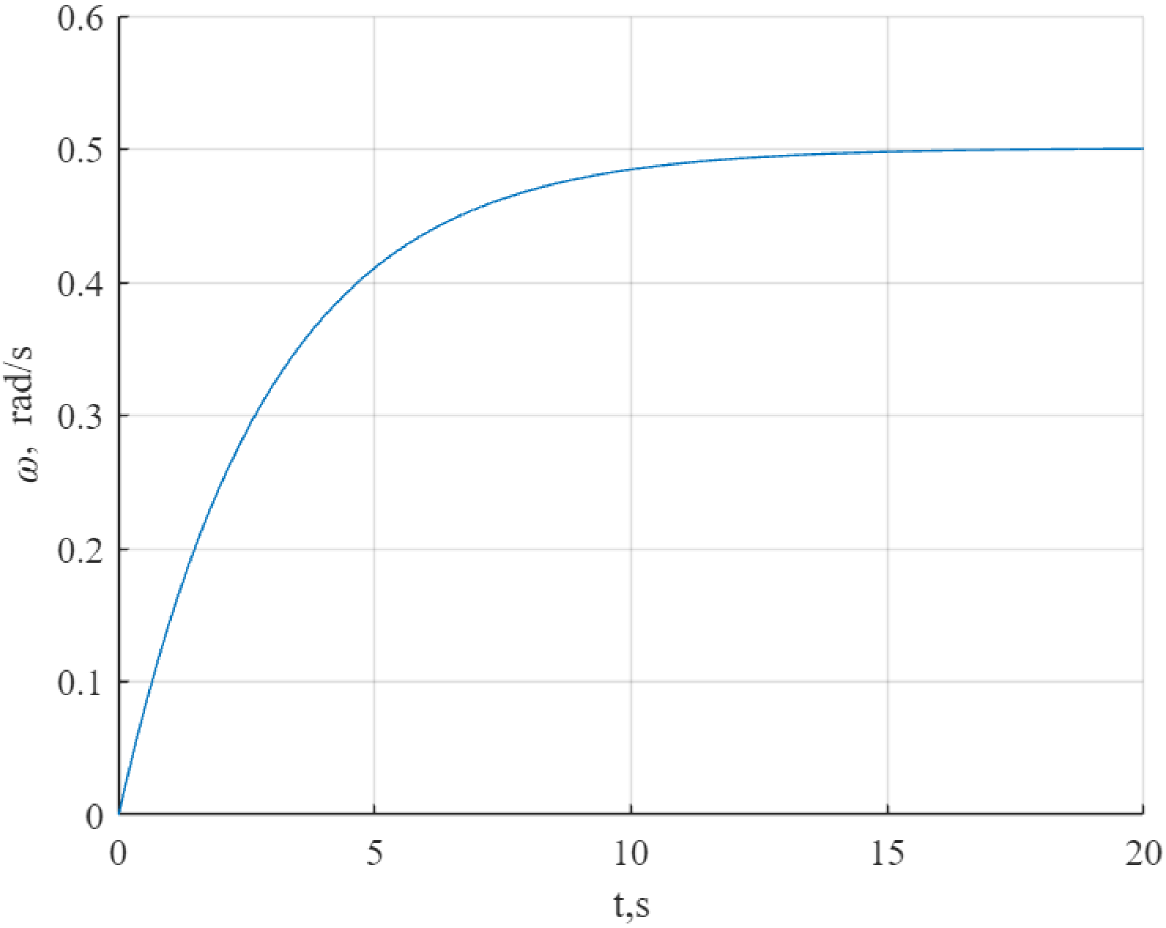

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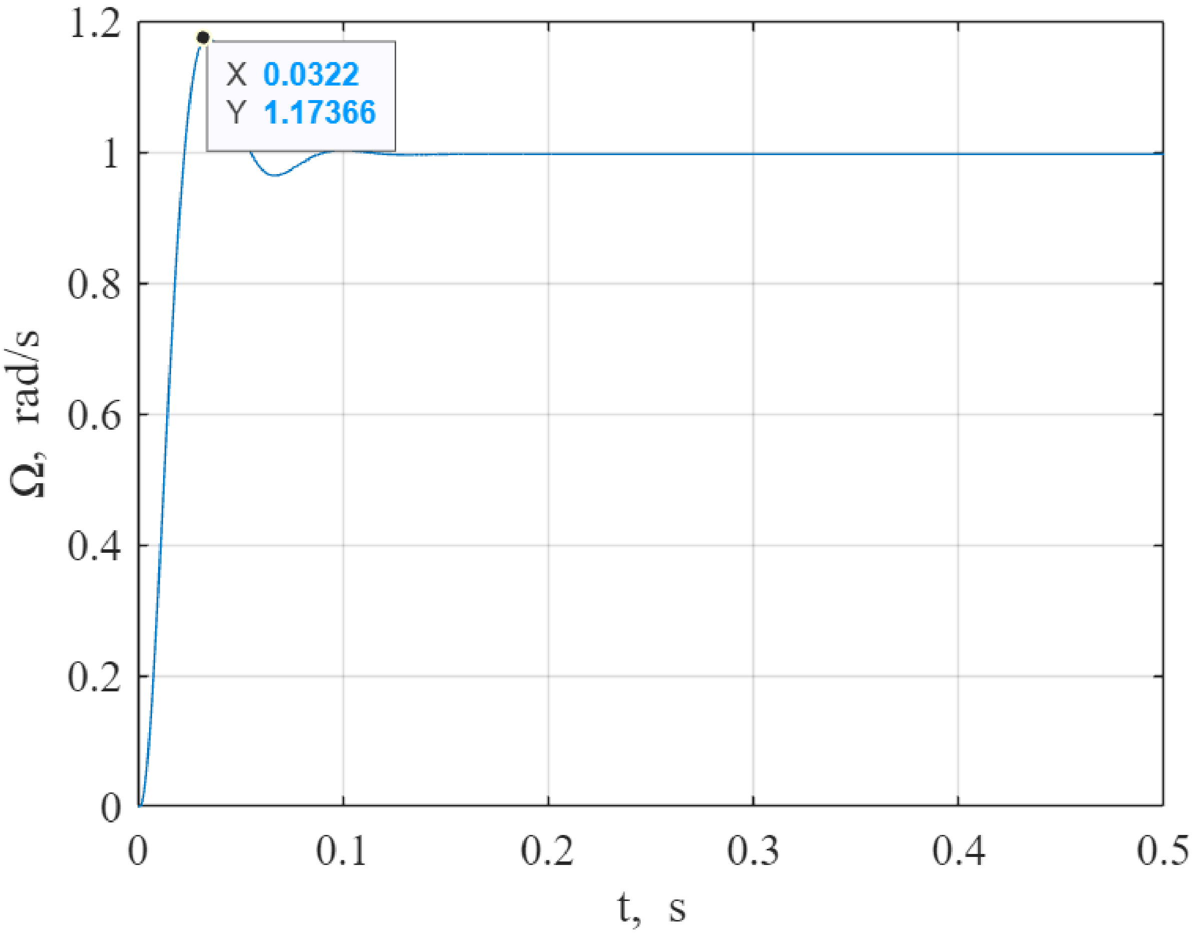
Figure 3. Transient responce.

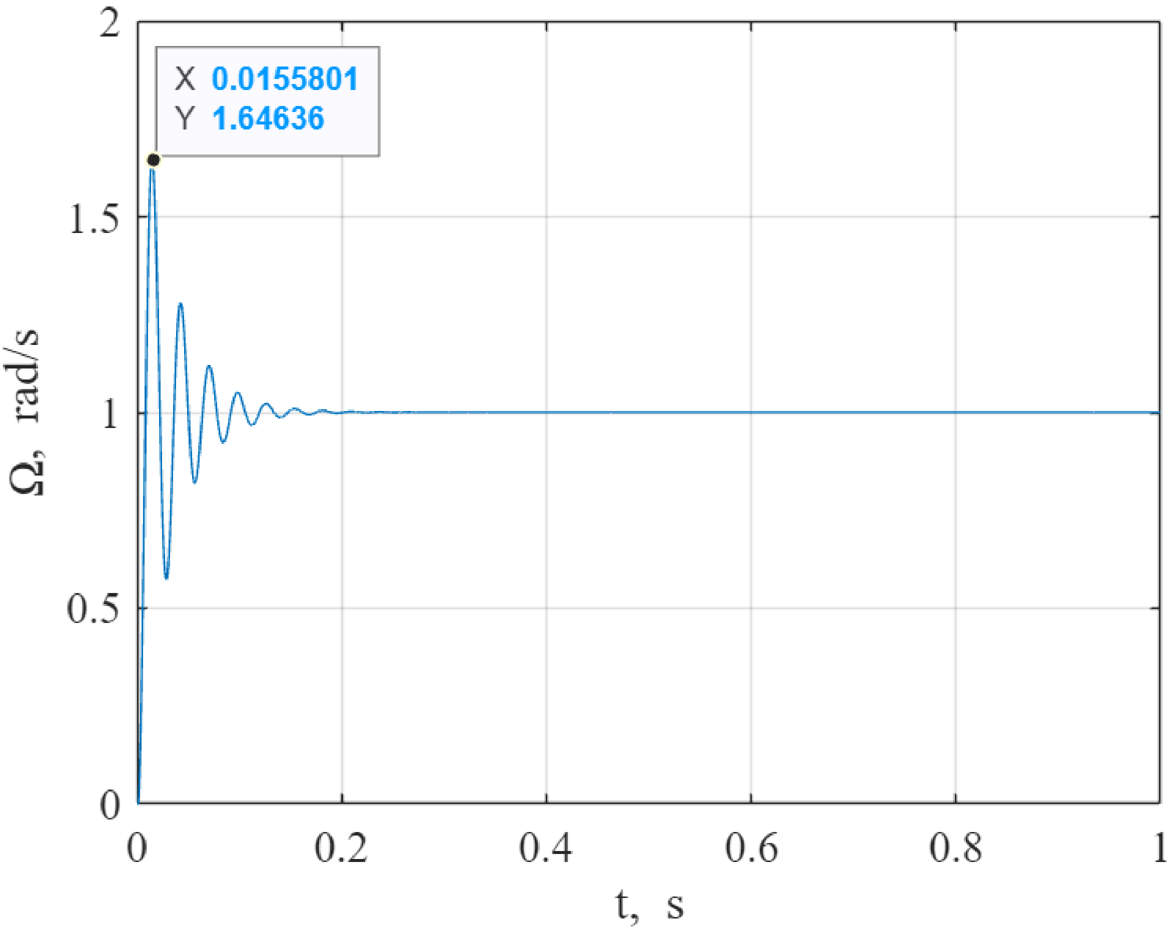
3. Calculate coefficients for P-controller, PI-controller and PID-controller by Ziegler Nichols method.

Regulator	K_P	K_I	K_D
P-controller	5.9367	-	-
PI-controller	2.67154	1.710	-
PID-controller	3.5620	3.80	8.34

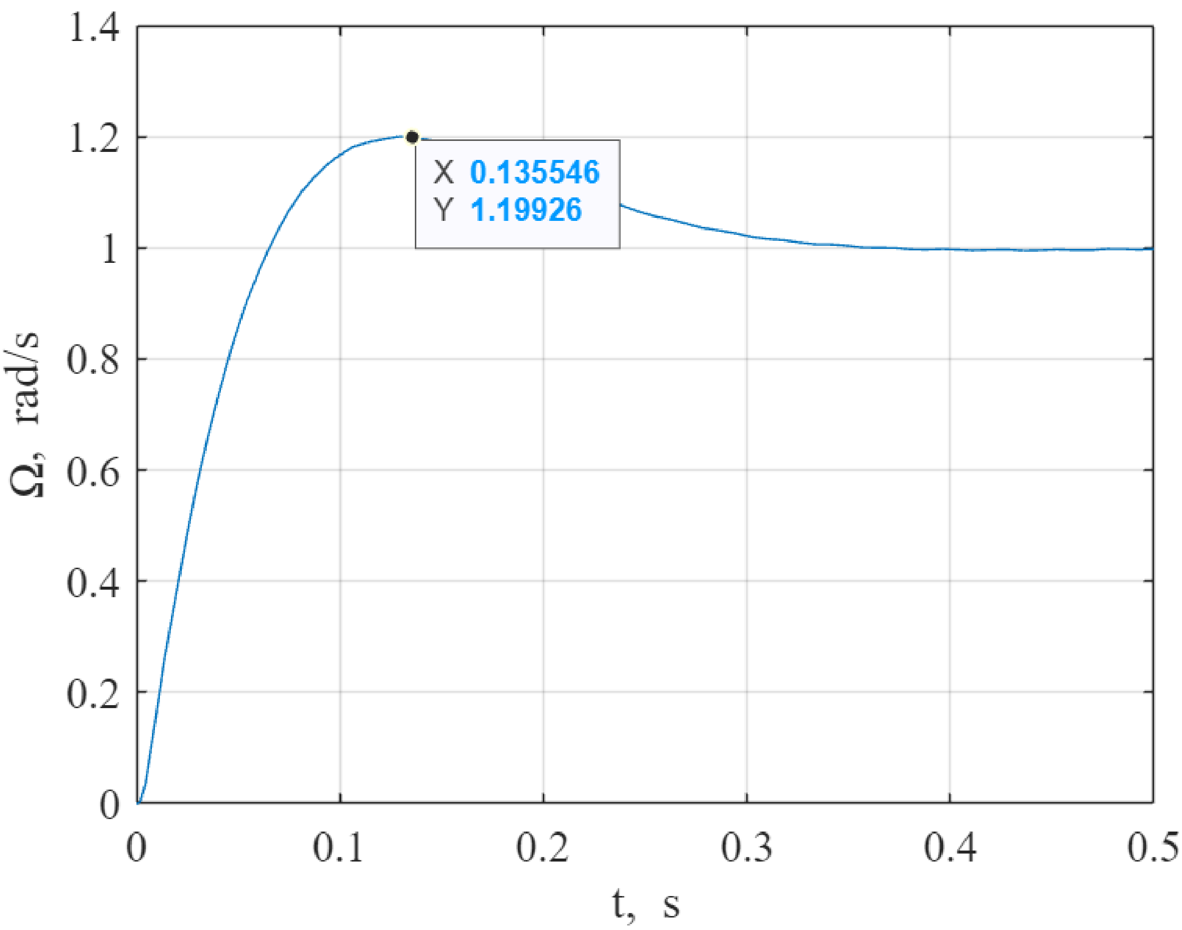
4. Simulate the synthesized control system.



a) P-controller

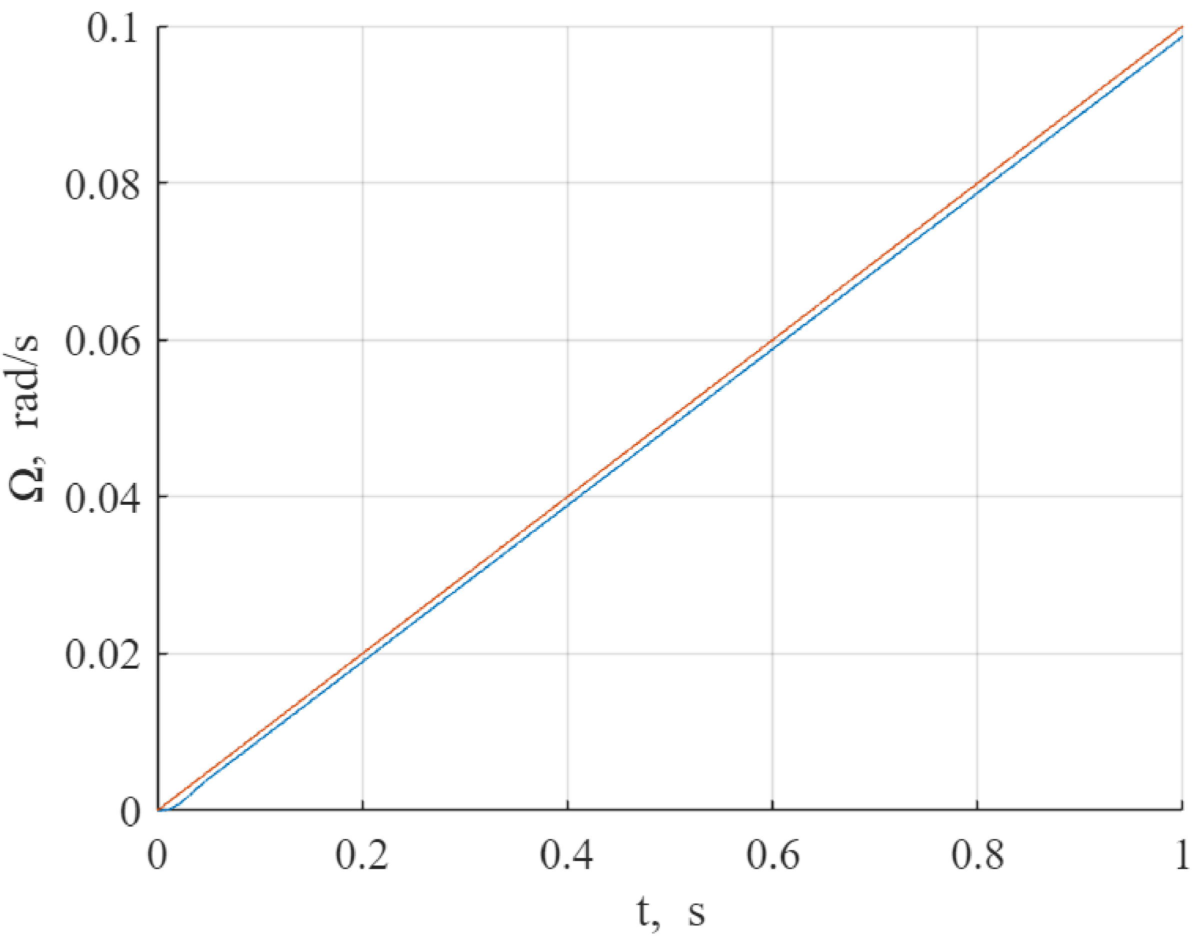


b) PI-controller

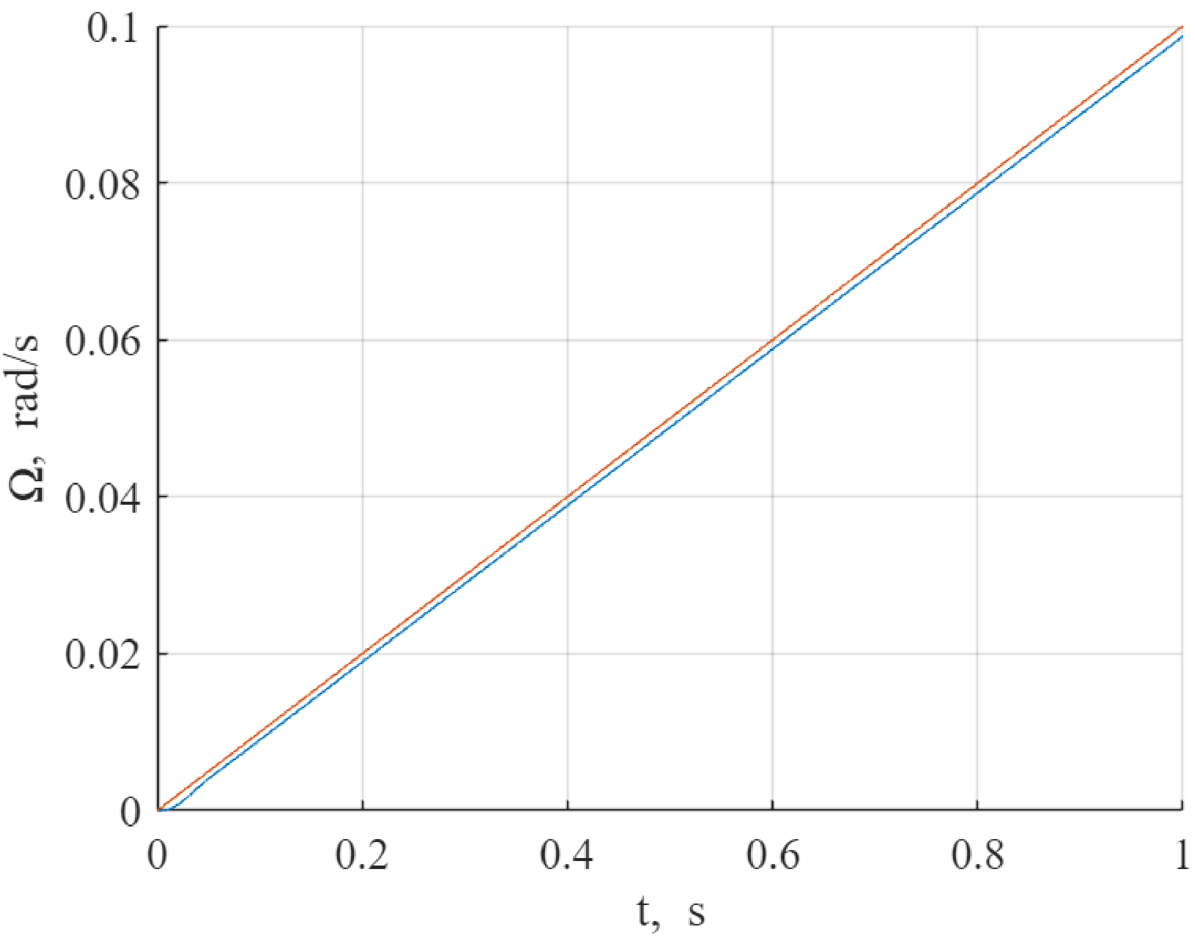


c) PID-controller

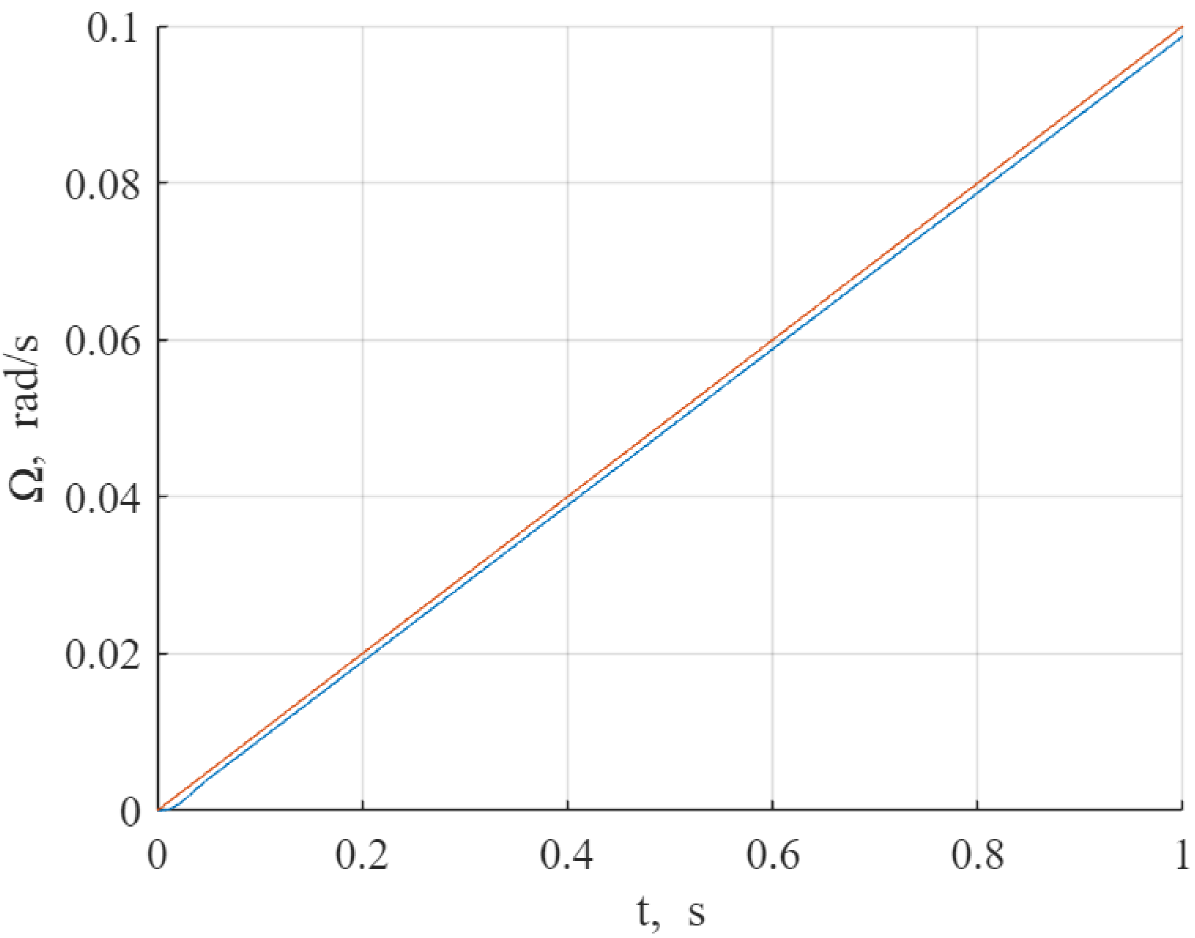
Figure 4. Graph of velocity for reference signal g(t) = 1 rad/s.



a) P-controller



b) PI-controller



c) PID-controller

Figure 5. Graph of velocity for reference signal g(t) = 0.1·t.

5. Determine the quality indicators of control systems for each regulator.

Regulator	Overshoot	Transient time	Steady state error (g(t) = const)	Fluctuation index
P-controller	0.18	0.05	0.00	2.43
PI-controller	0.65	0.1	-0.00	5.06
PID-controller	0.20	0.26	-0.03	1.01