Simulations in Mechatronic Design				
Title of exercise	Ex. 2 – Modelling of linear actuator in MATLAB/SIMULINK environment			
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Group	1	No. of points		
Academic year	2023/2024		Σ	/14

1. Mathematical model of the overload clutch

The following parameters of the coupling gear should be assumed:

- ratio

$$i_{ps} = 2$$

- efficiency

$$\eta_{ps} = 90\%.$$

$$M_{dop} = 150\ \mathrm{N \cdot mm}$$

d_2	thread pitch diameter	*5.35* mm
P	thread pitch	*1* mm
γ	helix angle	*3,4°*
α	thread angle	*30°*
μ	coefficient of friction of the screw-nut pair	*0,2*
M_{Fsr}	constant screw friction torque	*50* Nmm

$$M_p = M_{sr} \quad for \quad M_{sr} \le M_{dop}, \quad J_p = J_{msr} \quad for \quad M_{sr} \le M_{dop},$$
$$M_p = M_{dop} \quad for \quad M_{sr} > M_{dop}. \quad J_p = 0 \quad for \quad M_{sr} > M_{dop}.$$

2. Selection of a commercial reduction gear - calculations

Selection of a reduction gear:

The value of the torque reduced to the motor shaft (after using the reduction gear):

$$M_{\mathrm{red}} = M_{dop}/i_b \eta_b i_r \eta_r$$

$$M_{\mathrm{red}} = 5.69/1.5$$

$$M_{\mathrm{red}} = 5.69/2$$

$$M_{\mathrm{dop}} = 150$$

$$\eta_b = 0.9$$

$$i_r = 50$$

$$\eta_r = 0.81$$

$$i_b = 2$$

$$\eta_b = 0.9$$

$$i_r * \eta_r = 32.80$$

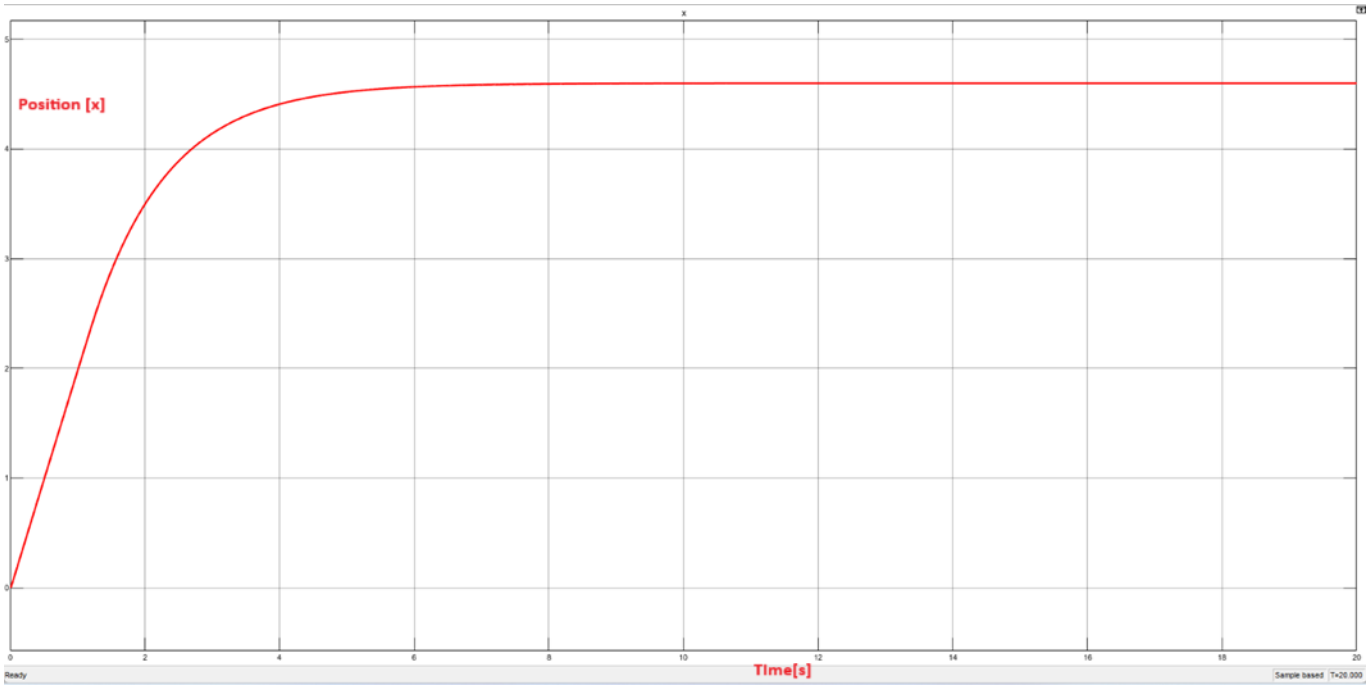
$$M_{\mathrm{red}} = 2.54\ [\mathrm{mNmm}]$$

Ratio ⊙⊙	5
No. of gear stages	2
Direction of Rotation	=
Efficiency	0.81
L (mm)	10.5
Mass (g)	7

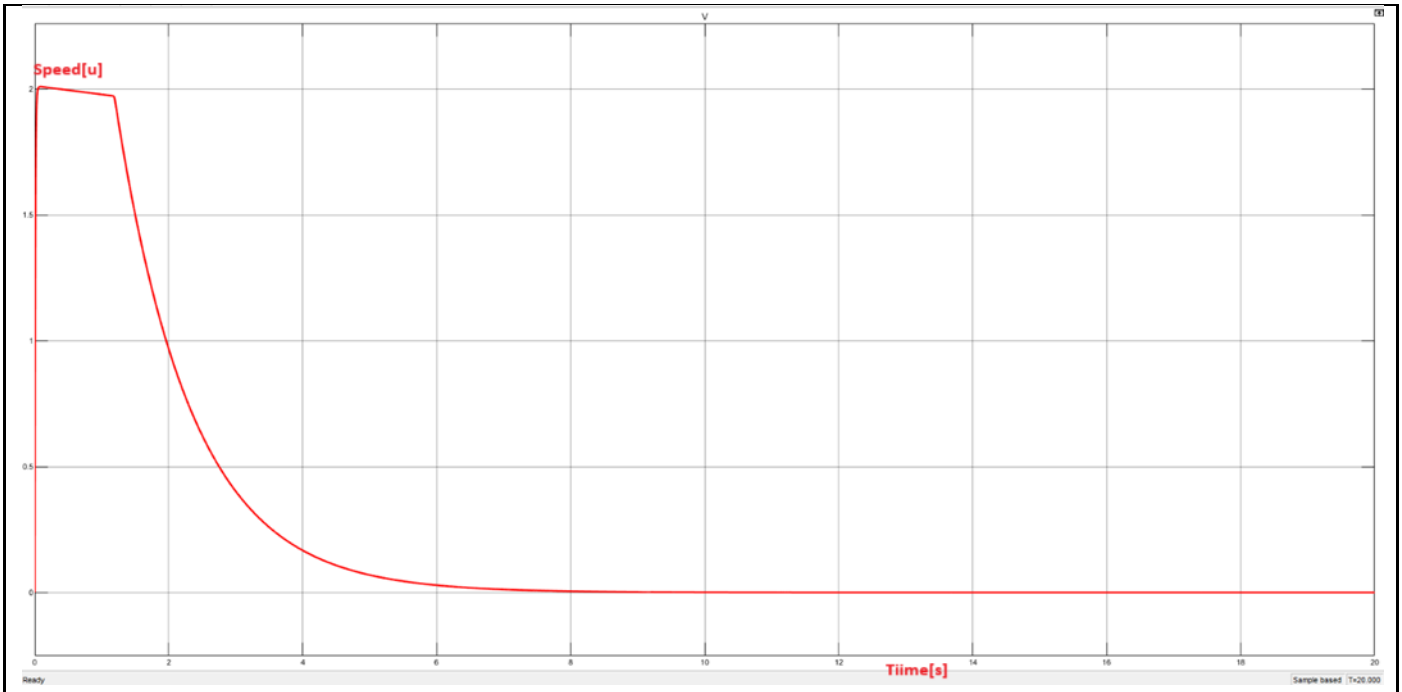
Motor catalogue number: 17N78
Reduction gear catalogue number: B16

3. The time waveforms of position and speed of the pusher for the set value of the position x_{set1} = 5 mm

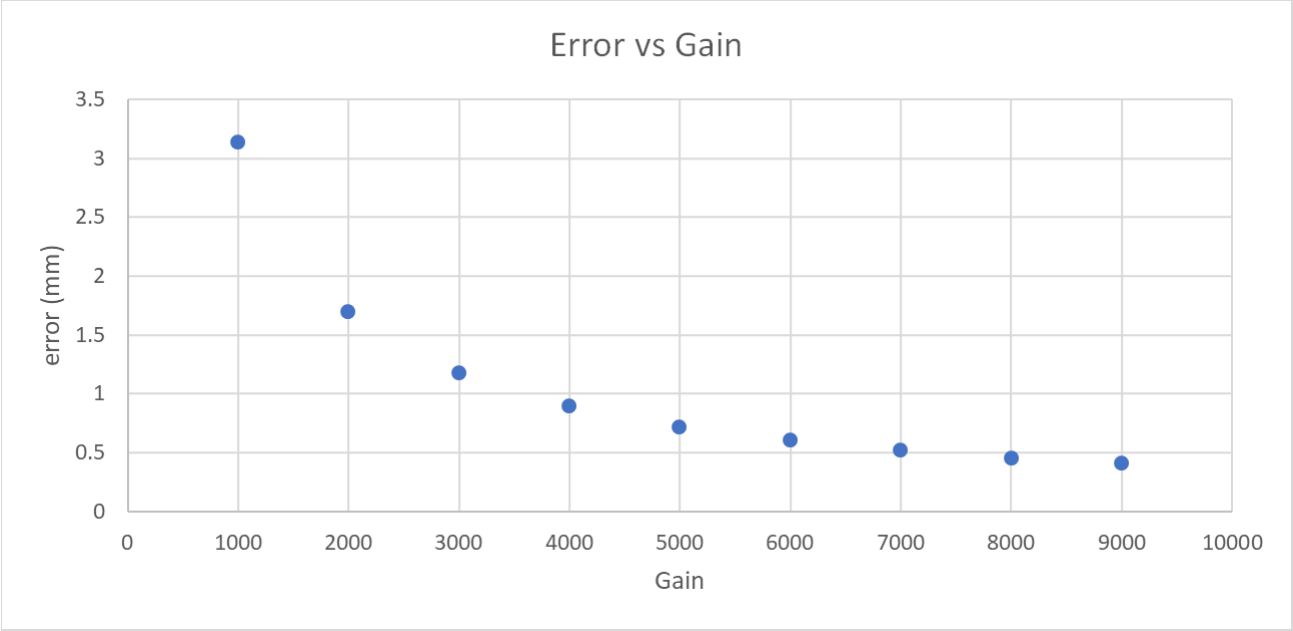
Position vs Time:



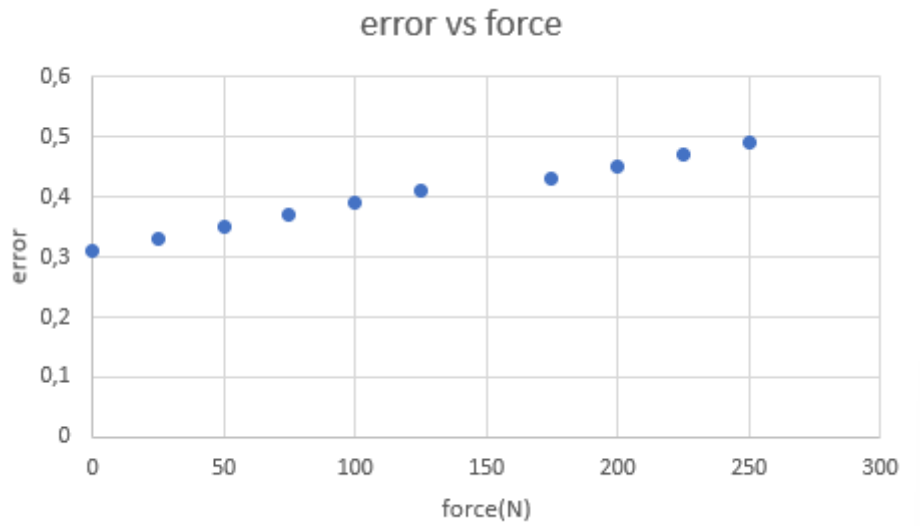
Speed vs Time:



4. Graph of the pusher positioning error σ_{x1} as a function of the controller gain

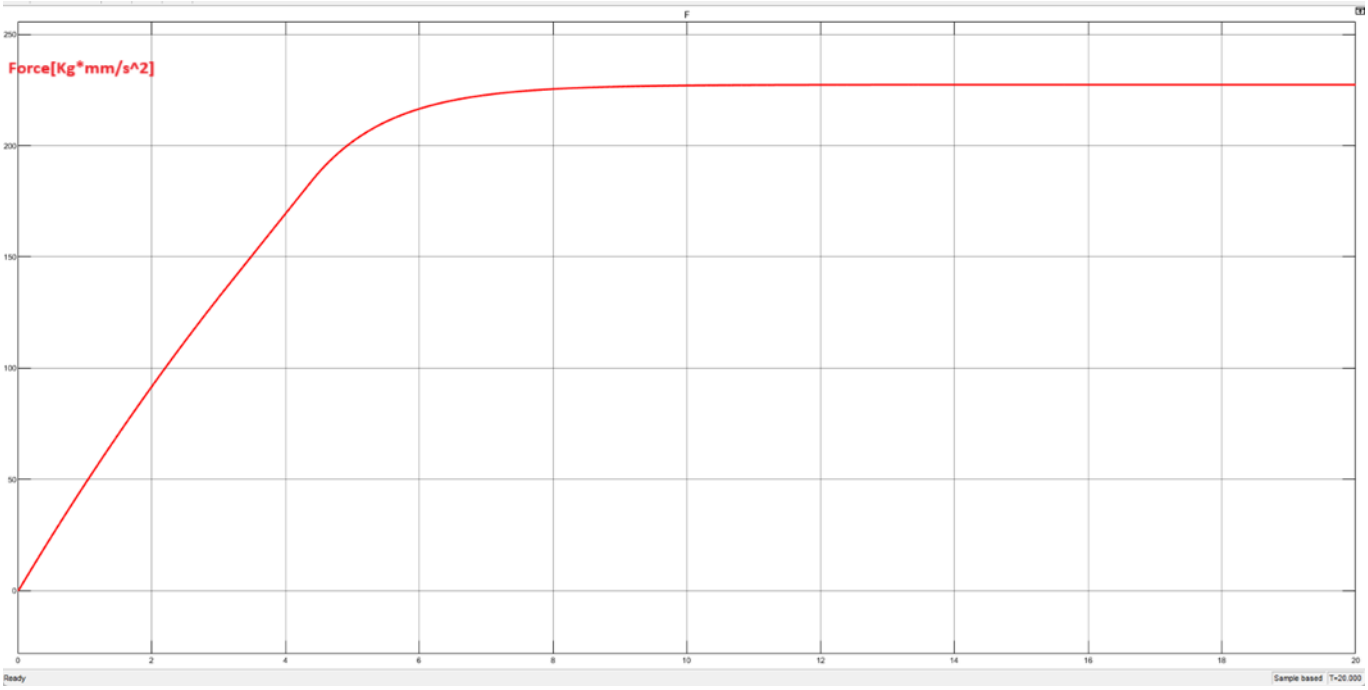


5. Graph of the steady-state positioning error of the pusher σ_x as a function of the loading force F

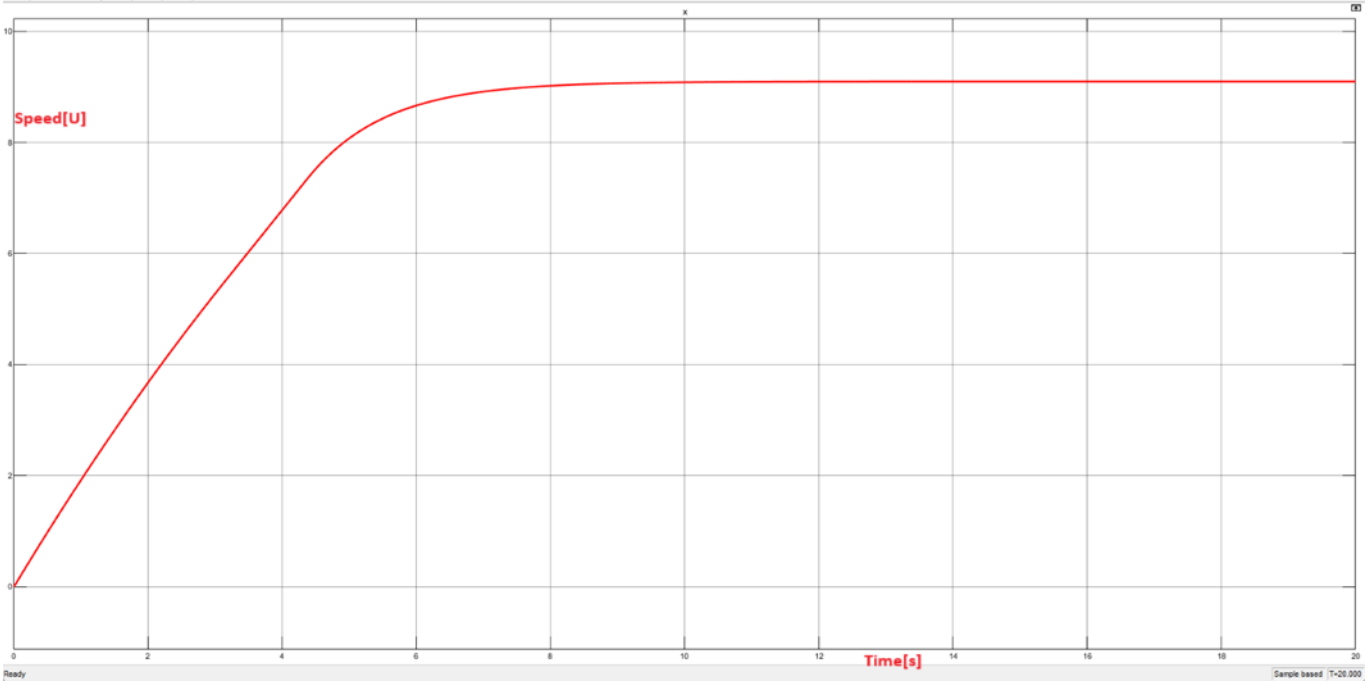


6. **The time waveforms of the loading force F, the speed and position of the pusher, loading torque and the inertial load of the motor for the set value of the position of the pusher x_{set2} = 10 mm**

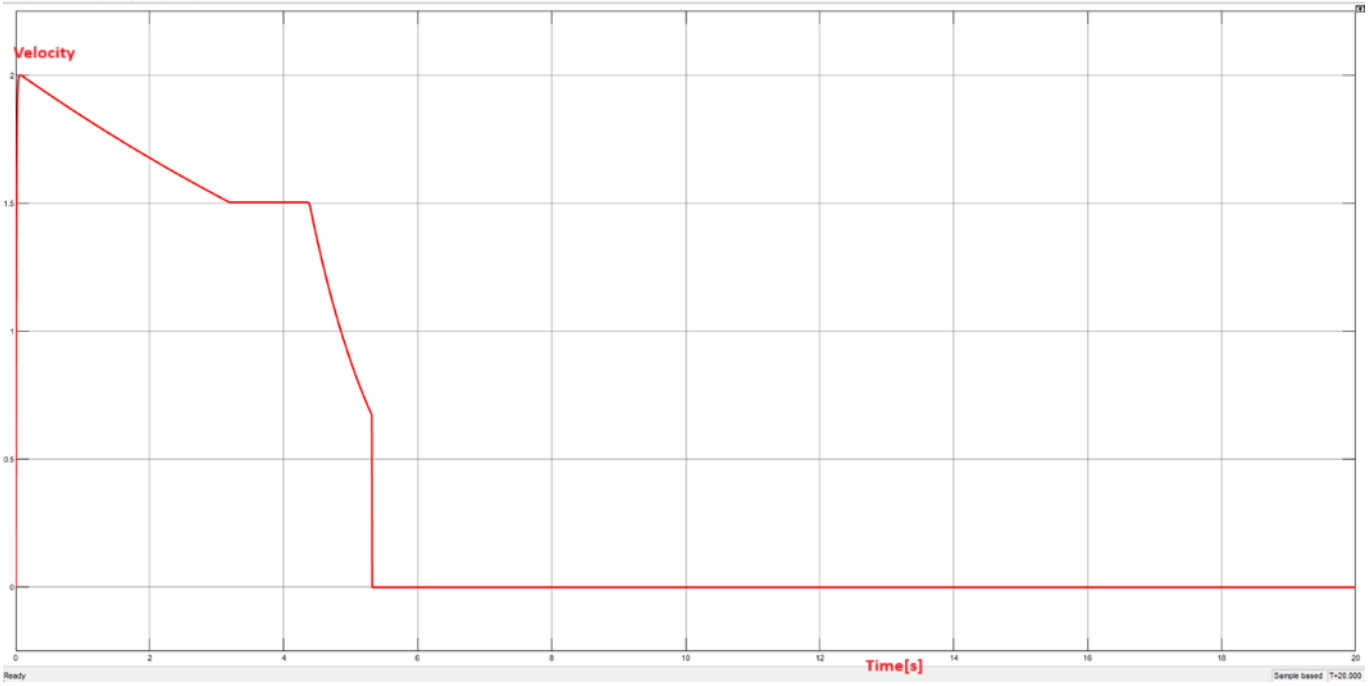
Force vs Time:



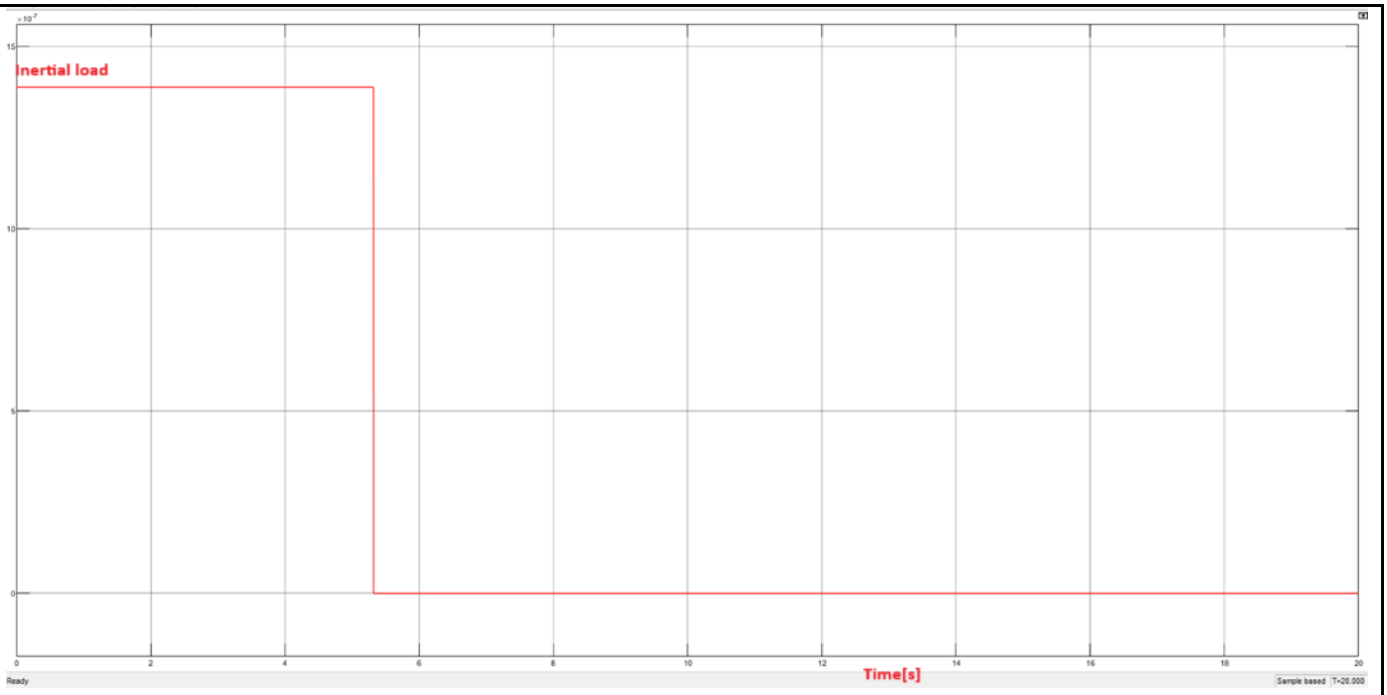
Speed vs Time:



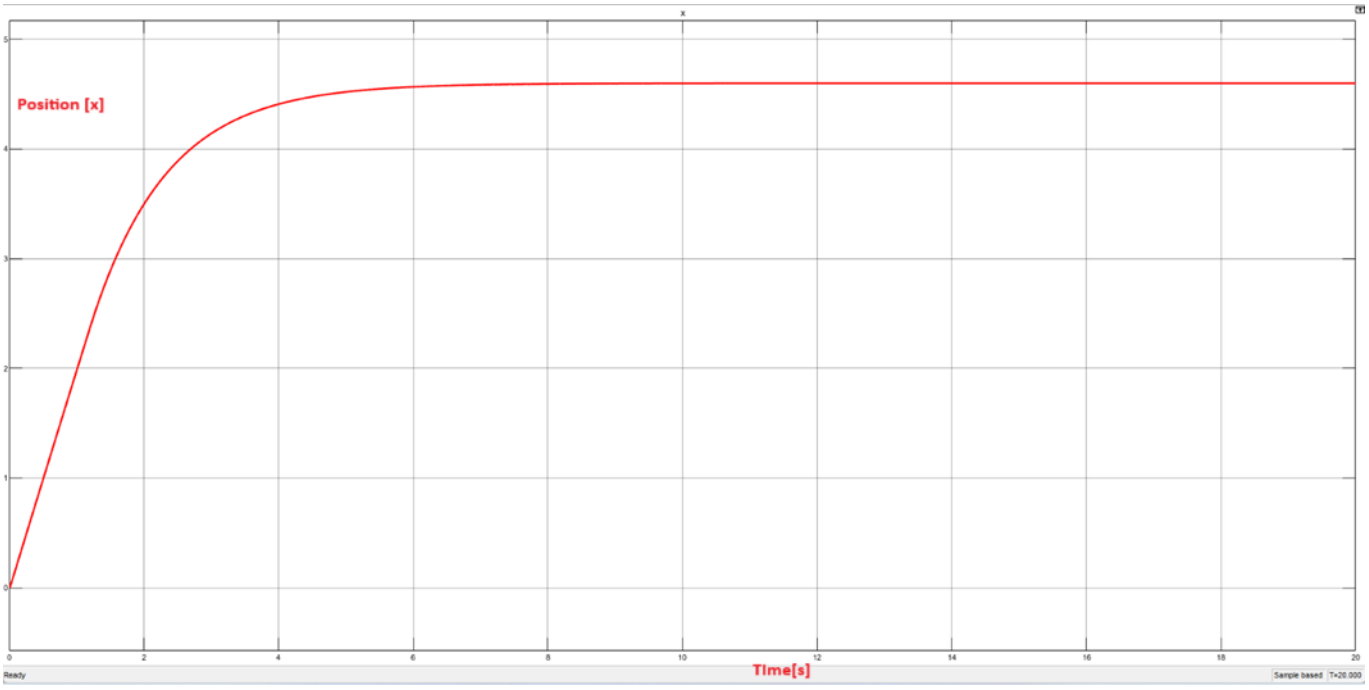
Velocity vs Time:



Inertial load vs Time:

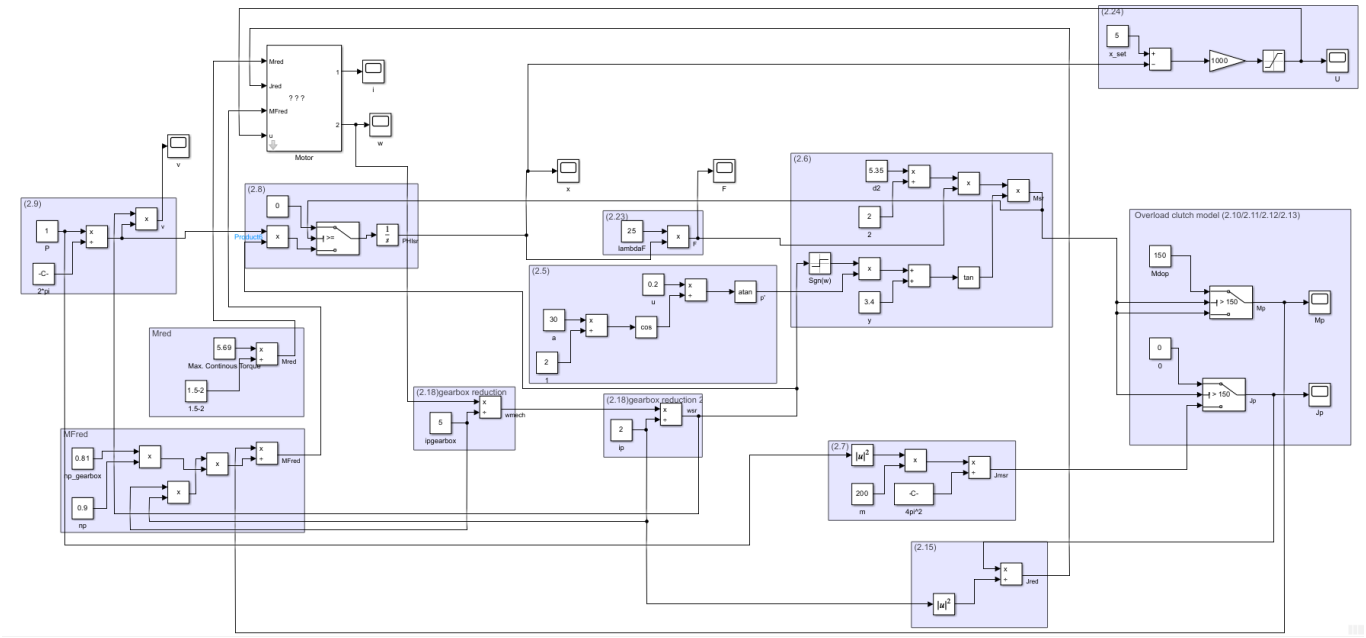


Position vs Time:



cont. point 6

7. Simulation model of the actuator with the control system



cont. point 7