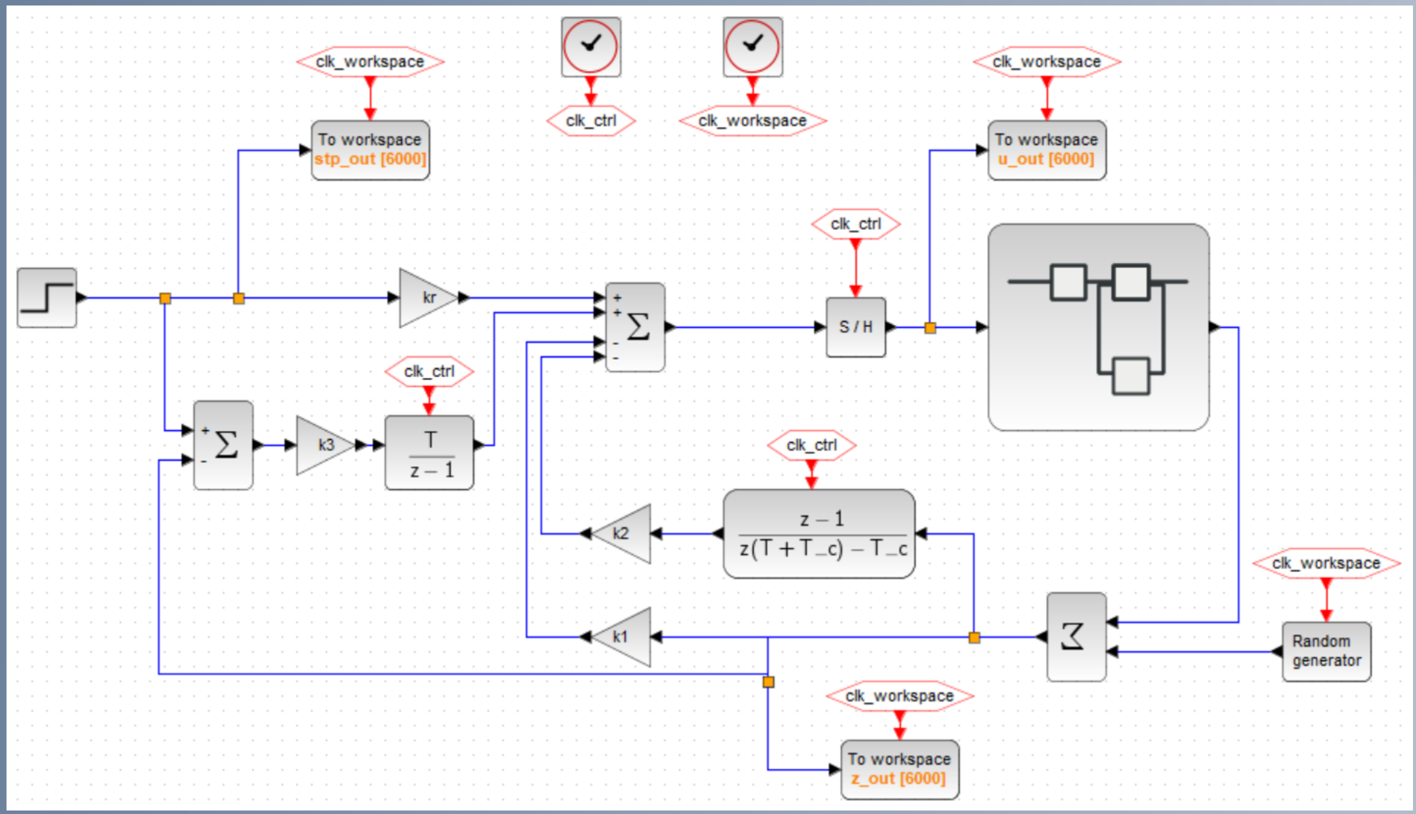
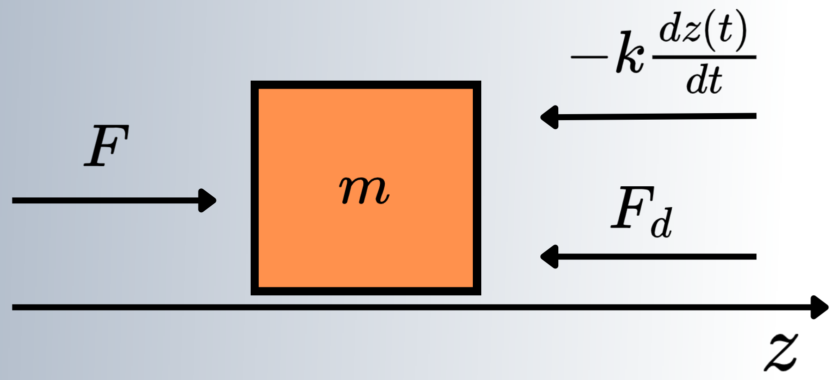
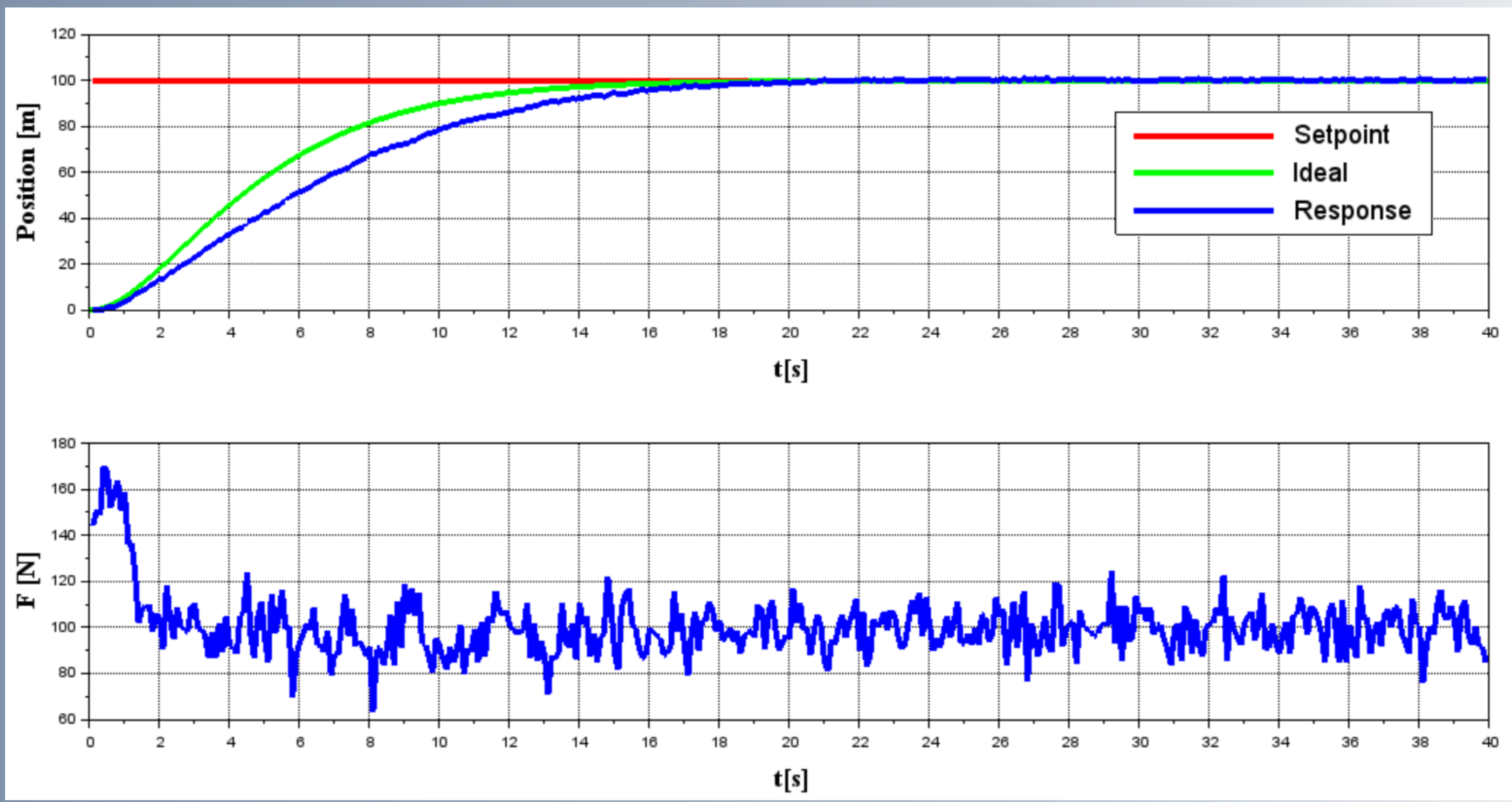
State feedback with integral







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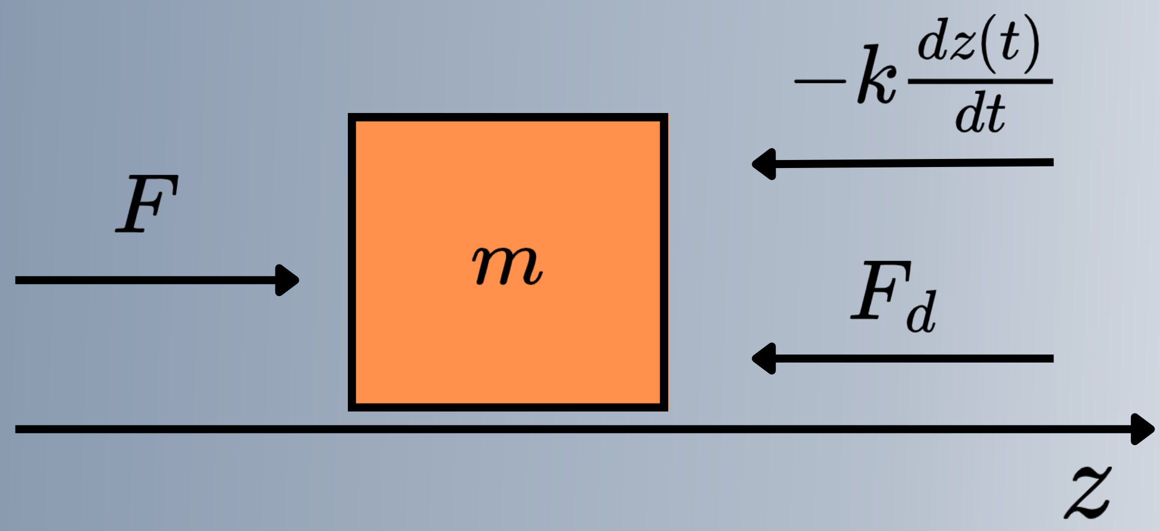
Code
https://github.com/simorxb/State-feedback-integral

Plant model



$$m\frac{d^2z(t)}{dt^2} = F - k\frac{dz(t)}{dt} - F_d$$

$$m = 10kg$$
$$k = 0.5\frac{Ns}{m}$$

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Control law - 1

Choose a state-feedback control law that includes the integral of the error:

$$F = k_r r - k_1 z - k_2 \dot{z} + k_3 \int (r(t) - z(t))$$

Substitute in the equation of motion, neglecting the disturbance F_d that is unknown:

$$m\ddot{z} = k_r r - k_1 z - k_2 \dot{z} + k_3 \int (r(t) - z(t)) - k\dot{z}$$

Switch to the frequency domain and find the transfer function from r to z:

$$\frac{Z(s)}{R(s)} = G_c(s) = \frac{s\frac{k_r}{m} + \frac{k_3}{m}}{s^3 + \frac{k_2 + k}{m}s^2 + \frac{k_1}{m}s + \frac{k_3}{m}}$$

Control law - 2

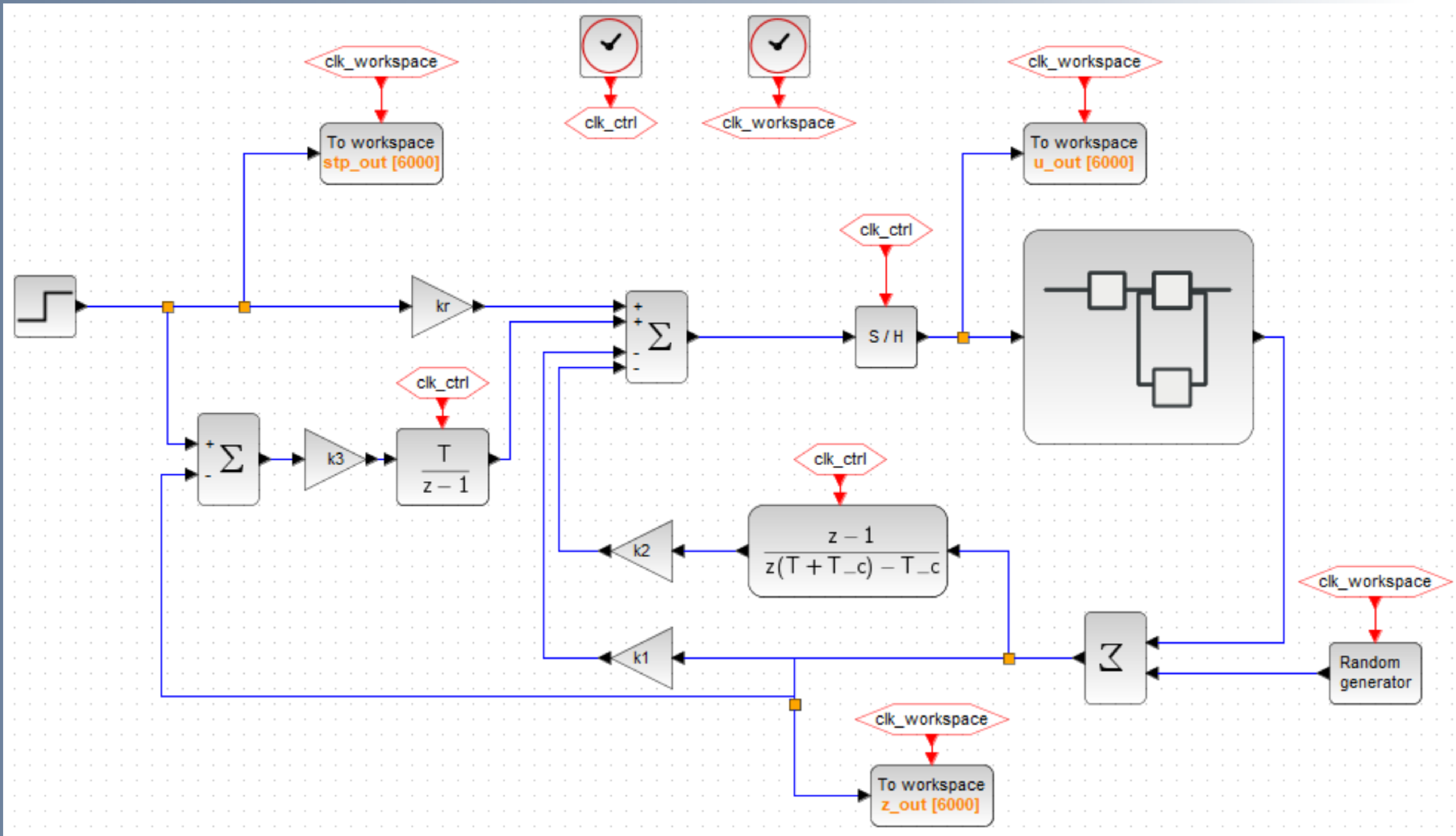
Choose a desired transfer function with the same form, with time to 90% = 10 seconds and steady-state gain = 1:

$$T(s) = \frac{0.15s+0.064}{s^3+1.2s^2+0.48s+0.064}$$

Determine k_r, k_1, k_2, k_3 so that $G_c(s) = T(s)$:

$$k_r = 0.15m = 1.5$$
$$k_1 = 0.48m = 4.8$$
$$k_2 = 1.2m - k = 11.5$$
$$k_3 = 0.064m = 0.64$$

Control architecture in Xcos



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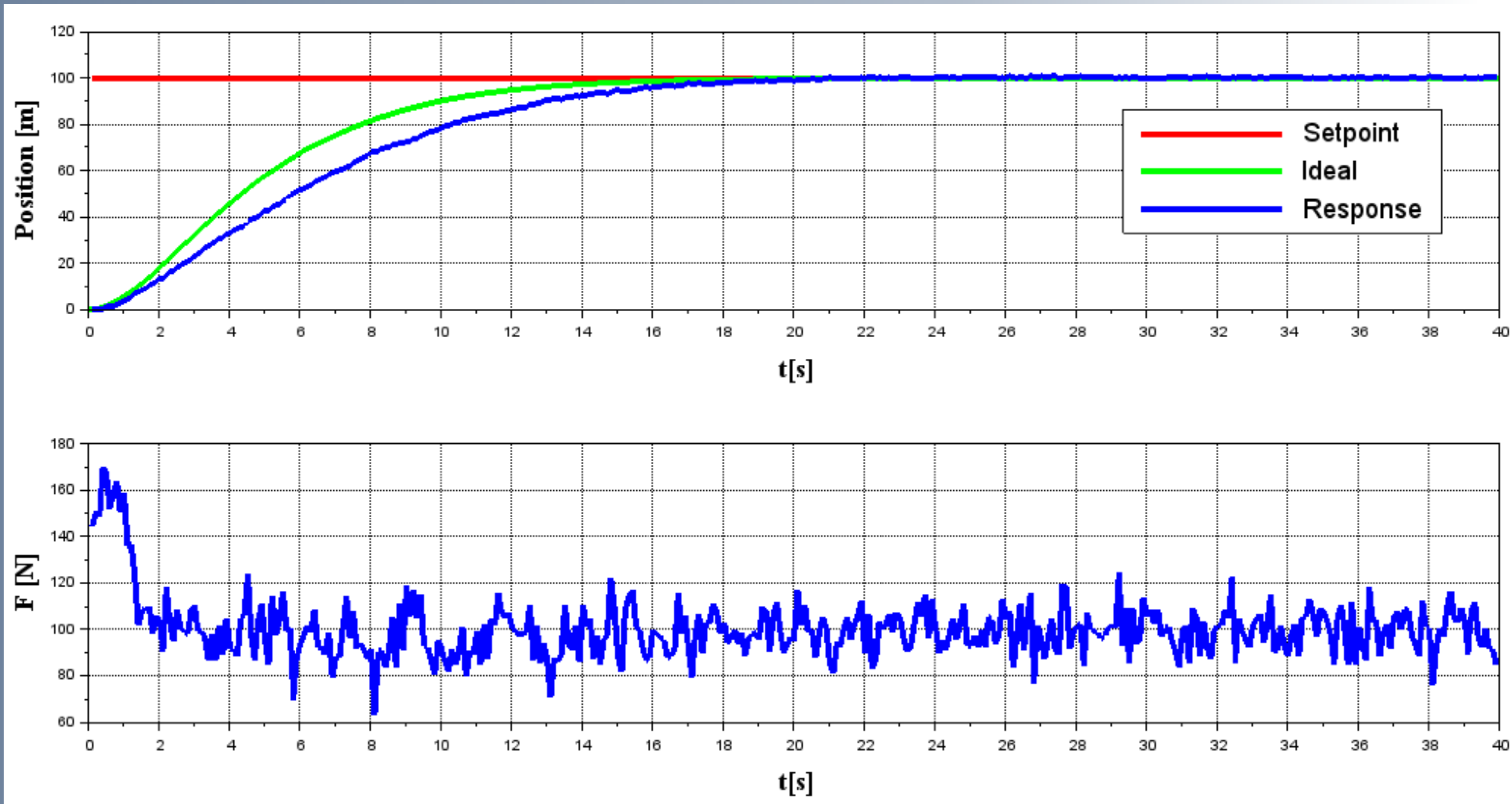
Simulation result



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