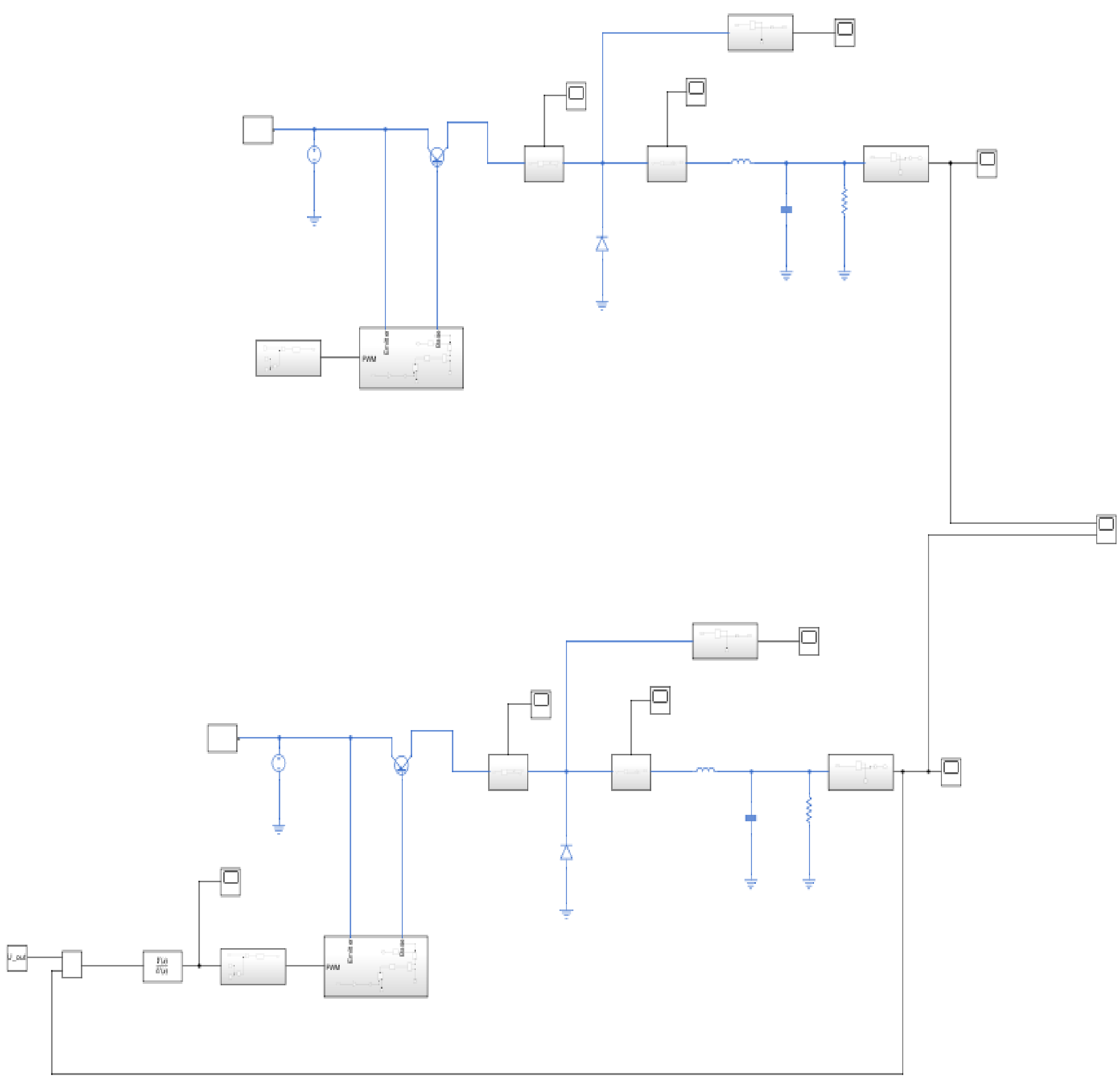
Power Electronics project

part 5

Simulink model: first one from part 4 with residual parameters & the second one with the controller

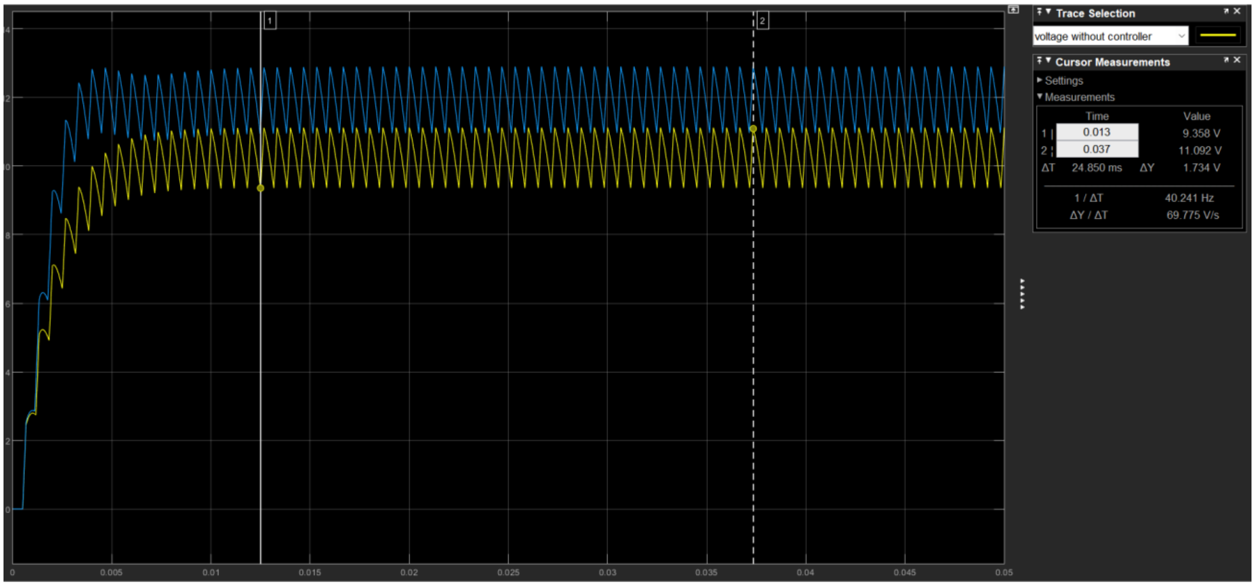


Code:

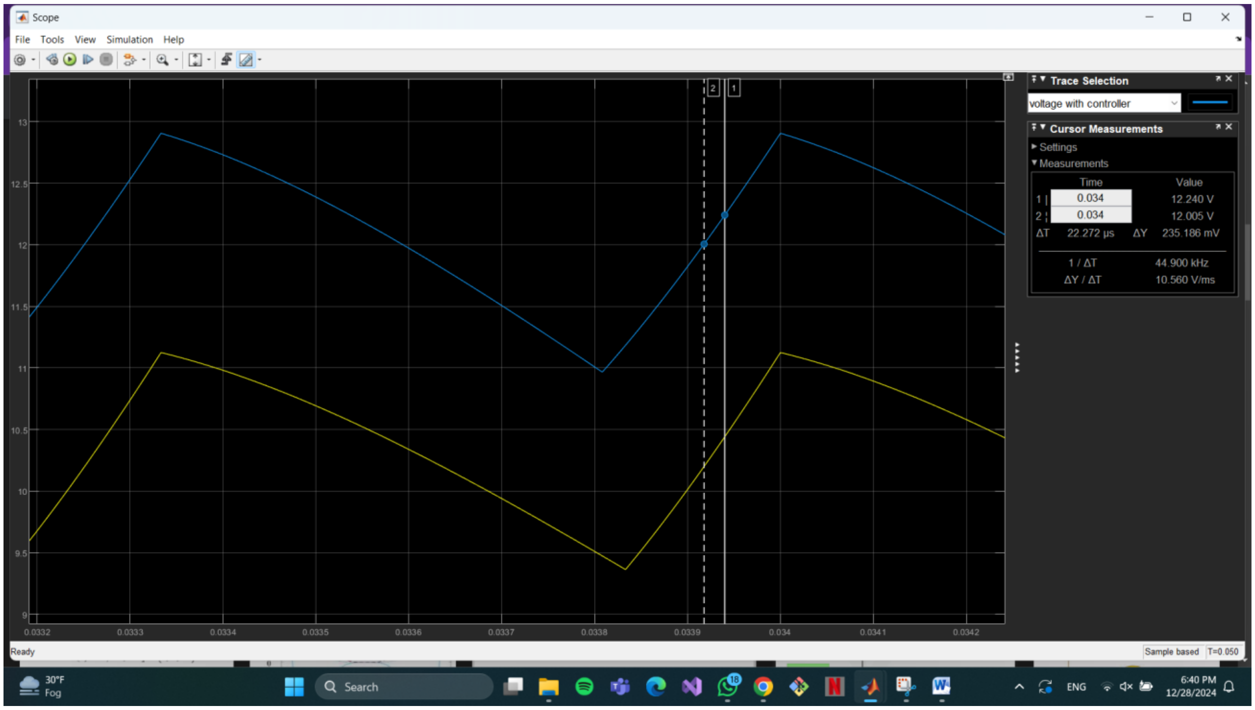
```
U_in = 48;
U_out = 12;
frequency = 1500;
R = 2.4;

L = 0.006;
C = 0.000104;
I_out = 5;

sigma = 0.06;
t_r = 0.007;
zeta = (abs(log(sigma)))/sqrt(log(sigma)^2 + pi^2);

w_n = 4/(t_r* zeta);

A = [0 -1/L; 1/C -1/(R*C)];
B = [U_in/L; 0];
C = [0 1];
D = 0;

[nump, denp] = ss2tf(A, B, C, D);
H_p = tf(nump, denp);

H_o = tf([0, w_n^2], [1, 2*zeta*w_n, w_n^2]);
H_c = 1/H_p * H_o/(1-H_o);
% H_c = 1/H_p * feedback(H_o, 1);
[numc, denc] = tfdata(H_c);
```

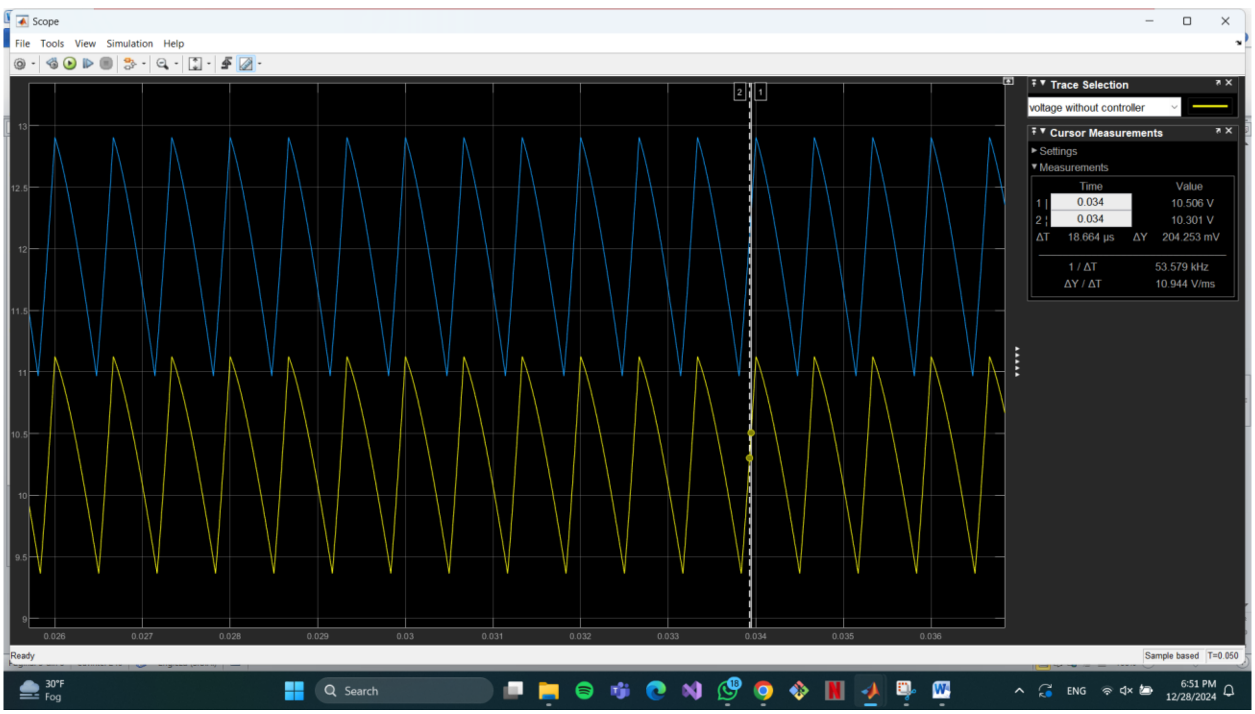
Output voltages (compared on the same scope) :

- blue : output voltage with controller
- yellow : output voltage without controller

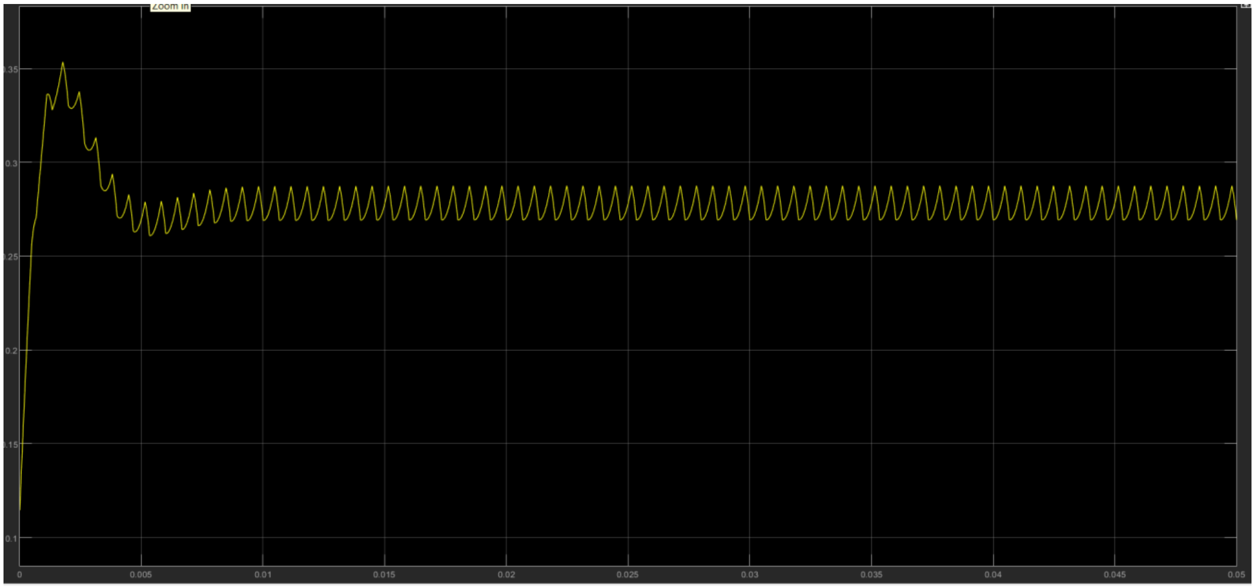


- we can see that the blue signal is increased from the yellow signal
- the average output voltage of the system with the controller matches the desired value of 12V (value of the output voltage given in the first project class), while the average output voltage of the system from part 4(with residual elements and without the controller) is around 10 V.
- for the blue signal, the steady state is at 12 V => overshoot = 7.45% & settling time = 3.4E-8 s (+2% = 12.24, -2% = 11.76)
- for the yellow signal, the steady state is at 10.3 V => overshoot = 7.76% & settling time = 3.4E-8 s (+2% = 10.506 , -2% = 10.094)


Scope
File Tools View Simulation Help
Trace Selection
voltage with controller
Cursor Measurements
Settings
Measurements
Time Value
1 0.034 12.240 V
2 0.034 12.005 V
ΔT 22.272 µs ΔY 235.186 mV
1 / ΔT 44.900 kHz
ΔY / ΔT 10.560 V/ms
Ready
Sample based T=0.050


Scope
File Tools View Simulation Help
Trace Selection
voltage without controller
Cursor Measurements
Settings
Measurements
Time Value
1 0.034 10.506 V
2 0.034 10.301 V
ΔT 18.664 µs ΔY 204.253 mV
1 / ΔT 53.579 kHz
ΔY / ΔT 10.944 V/ms
Ready
Sample based T=0.050

Command value (output of the controller Hc)



- the controller compensates for the residual elements by increasing the output voltage such that the average output voltage fits the desired value of 12 V.
- without the controller, the duty cycle is fixed => output voltage is insufficient, but with the controller, the command value compensates for disturbances.
- in conclusion, the controller improves the system performance by adjusting the residual parameters, obtaining the wanted output voltage.