

## CONTROL METHODS

### Method#02 - PID control: Tuning PID controller of the LTI, SISO system

Let's consider the following UAV stabilization system

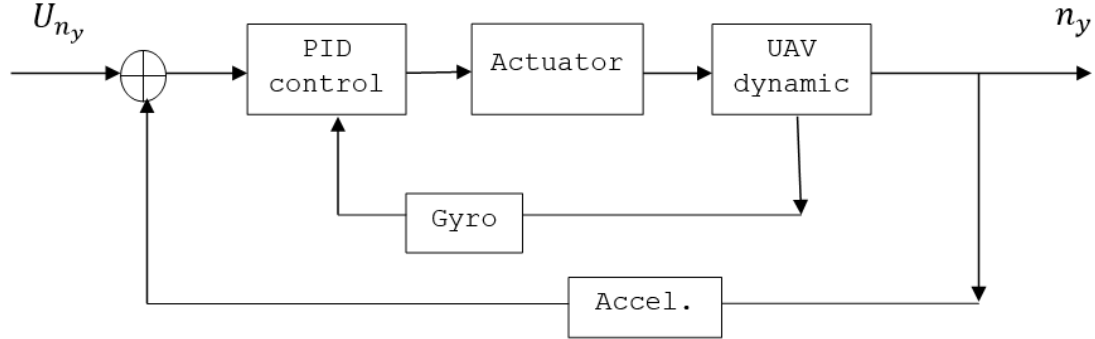


Fig.2.01 - Functional block-diagram of the UAV stabilization system

#### Assumptions

Measurement noise & errors of the Gyro and Accelerometer aren't taking into account in the model:  $W_{gyro}(s)=1$ ,  $W_{accel}(s)=1$ .

...

#### PID controller

$$\delta(t) = K_p e(t) + K_D \dot{e}(t) + K_I \int_0^T e(t) dt, \quad (2.01)$$

#### Actuator

$$W_{act} = \frac{1}{T_{act}s + 1}, \quad (2.02)$$

where  $T_{act} = \frac{1}{K_{act}}$  is actuator time constant,  $K_{act} = 20$ .

#### UAV dynamics

$$W_{\delta}^{\omega_z} = \frac{K(T_1s + 1)}{T_2^2s^2 + 2\xi T_2s + 1}, \quad W_{\omega_z}^{\dot{\theta}} = \frac{1}{T_1s + 1}, \quad W_{\dot{\theta}}^{n_y} = \frac{V}{g}, \quad (2.03)$$

Where

$$K = 1,$$

$$T_1 = 0.7 \text{ (s)}, \quad T_2 = 0.5 \text{ (s)},$$

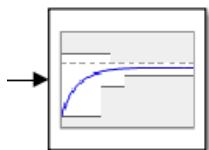
$$\xi = 0.3.$$

## 1<sup>st</sup> step - Initial PID coefficients load into Workspace

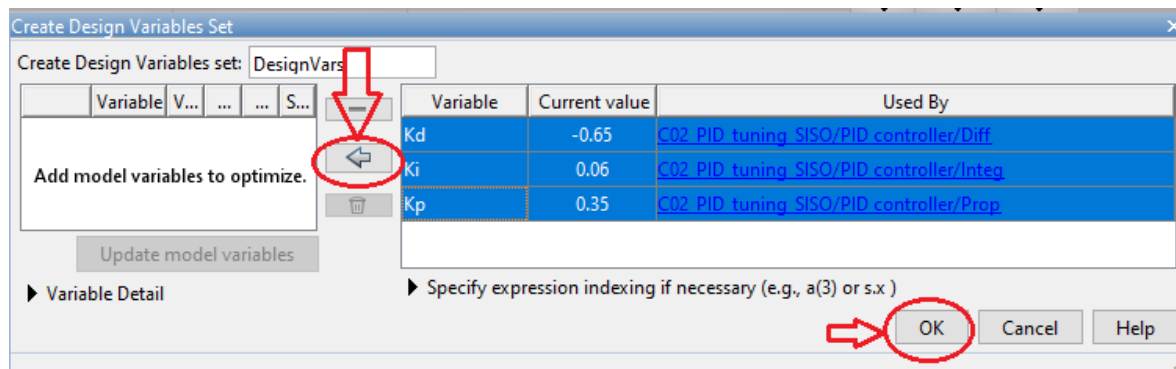
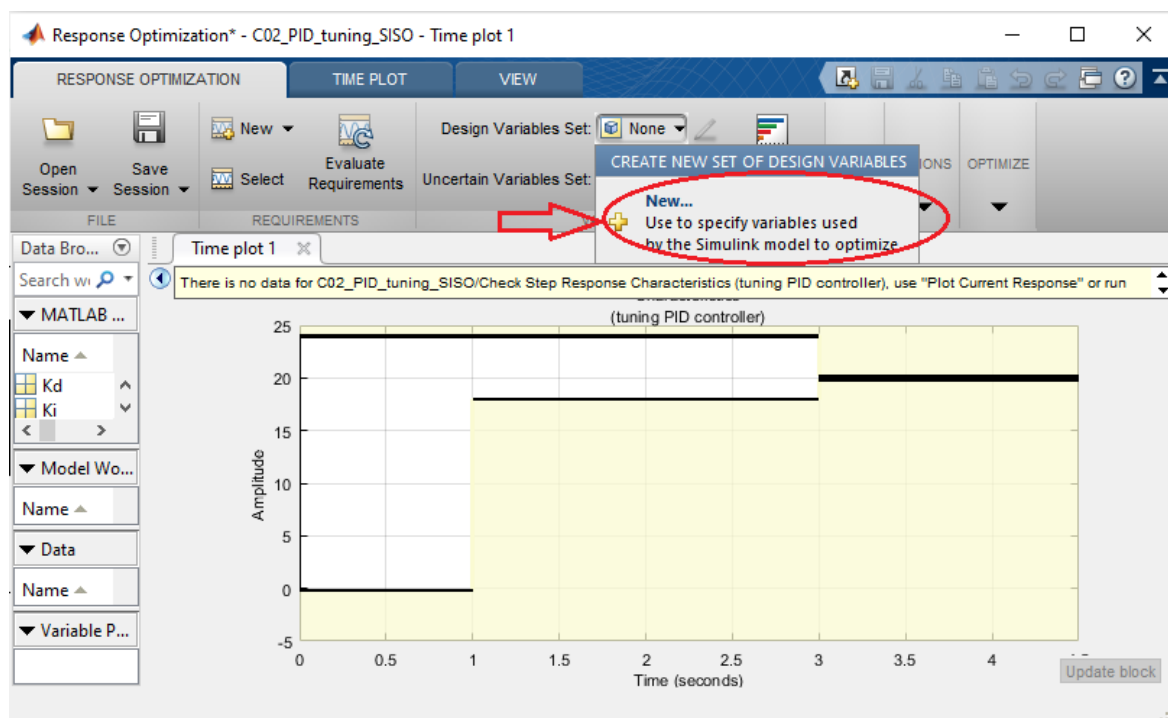
```
Command Window

>> clear all, close all
>> uiopen('D:\! MATLAB\!GitHub\Control\!done\2_PID\C02_PID_tuning_SISO.slx',1)
>> Kp = 0.35; Kd = -0.65; Ki = 0.06;
fx >> |
```

## 2<sup>nd</sup> step - Response Optimization setting

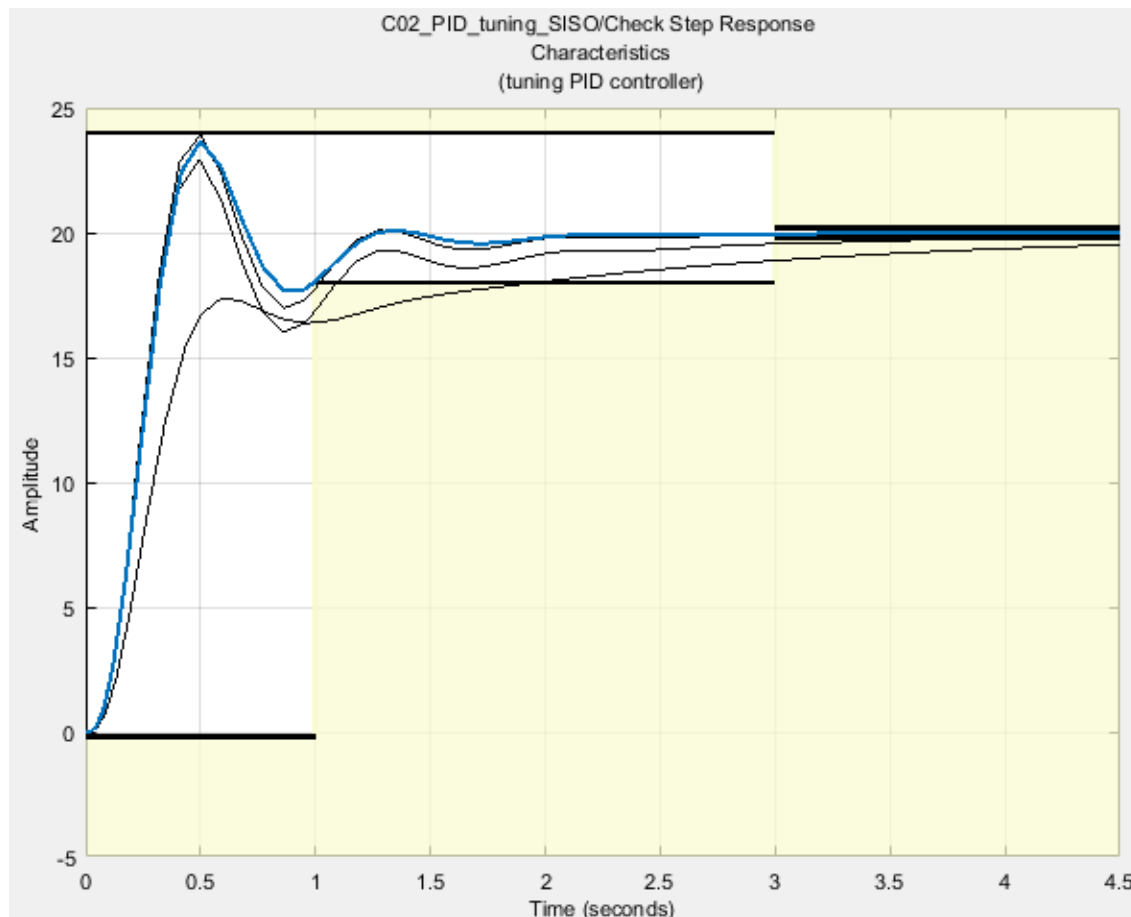


Check Step Response  
Characteristics  
(tuning PID controller)



Variable	Current value	Used By
Kd	-0.65	C02_PID_tuning_SISO/PID controller/Diff
Ki	0.06	C02_PID_tuning_SISO/PID controller/Integ
Kp	0.35	C02_PID_tuning_SISO/PID controller/Prop

### 3<sup>rd</sup> step - Optimize



### 4<sup>th</sup> step - Analysis of the optimization results

Optimization Progress Report

Iteration	F-count	Check Step Response Characteristics (tuning PID controller) (Upper) (<=0)
0	7	83.2226
1	14	16.4927
2	21	2.5773
3	28	0.3768
4	35	0.0122
5	42	-0.0025
6	49	-0.0025

Optimized variable values written to 'DesignVars' in the Design Optimization workspace  
'C02\_PID\_tuning\_SISO' updated with optimized values  
Optimized requirement values written to 'ReqValues' in the Design Optimization workspace

Optimization solver output:

Local minimum found that satisfies the constraints.

Optimization completed because the objective function is non-decreasing in feasible directions to within the selected value of the optimality tolerance.

Save Iteration... Display Options... Optimize

Data Browser

Search workspace variables

MATLAB Workspace

Name	Value
Kd	-2.4934
Ki	0.4485
Kp	0.3115

Model Workspace (C02\_PID\_tuning\_SISO)

Name	Value
sintez_sys_stab_op...	1x1 Sessio...

Data

Name	Value
BlockReq	1x1 BlockR...
DesignVars	3x1 Contin...
ReqValues	1x1 struct

Variable Preview