

Time Delay and Lag

$$G(s) = \frac{1}{1 + 2s} e^{-s}$$

Set Point Optimization

	Controllers			
Parameters	PID	I-PD	PI-D	PIDA
Controller Transfer Function	$C(s) = \frac{1.781 s^2 + 4.488 s + 1.855}{0.01534 s^2 + 2.413 s}$	$C_1(s) = \frac{1.854}{s}$ $C_2(s) = \frac{1.129 s + 2.797}{0.0252 s + 1.0}$	$C_1(s) = 1.9351$ $C_2(s) = \frac{0.642}{s}$ $C_3(s) = \frac{0.7332 s}{0.004833 s + 1.0}$	$C(s) = \frac{0.5124 s^4 + 2.497 s^3 + 6.154 s^2 + 6.422 s + 1.979}{0.04009 s^4 + 0.5089 s^3 + 2.024 s^2 + 2.401 s}$
IAE	1,367896448	2,25580252	1,634459039	1,329083275
K_p	1,855034045	2,79670978	1,935132255	1,979416598
T_i	2,413012589	1,508322558	3,014054061	2,401441122
T_d	0,391543526	0,378646053	0,378909125	0,363410405
T_a				0,168411263
N	61,60650983	15,02267321	78,39270996	0,78457695
α				0,887089399
Phase margin	64.4619	59.5027	62.4248	60.7582
Gain Margin	2.0890	2.2463	2.0926	1.9160

Disturbance Rejection Optimization

	Controllers	
Parameters	PID	PIDA
Controller Transfer Function	$C(s) = \frac{1.692 s^2 + 3.751 s + 2.678}{0.01175 s^2 + 1.392 s}$	$C(s) = \frac{0.1379 s^4 + 1.278 s^3 + 4.042 s^2 + 6.279 s + 2.999}{0.005423 s^4 + 0.1104 s^3 + 0.742 s^2 + 1.642 s}$
IAE	0,635725911	0,593586031
K_p	2,67837325	2,998907108
T_i	1,392153047	1,641945179
T_d	0,445254564	0,327975224
T_a		0,102416601
N	52,77429525	1,785223959
α		0,763852964
Phase margin	39.1258	35.7028
Gain Margin	1.4366	1.2003

$$G(s) = \frac{1}{1 + 5s} e^{-s}$$

Set Point Optimization

	Controllers			
Parameters	PID	I-PD	PI-D	PIDA
Controller Transfer Function	$C(s) = \frac{9.607 s^2 + 22.37 s + 4.093}{0.05902 s^2 + 5.455 s}$	$C_1(s) = \frac{3.585}{s}$ $C_2(s) = \frac{2.786 s + 6.667}{0.03059 s + 1.0}$	$C_1(s) = 4.4611$ $C_2(s) = \frac{0.642}{s}$ $C_3(s) = \frac{1.808 s}{0.01074 s + 1.0}$	$C(s) = \frac{4.507 s^4 + 17.26 s^3 + 37.9 s^2 + 29.38 s + 4.51}{0.138 s^4 + 1.599 s^3 + 5.643 s^2 + 5.486 s}$
IAE	1,379428407	2,366290952	1,6645073	1,347641643
K_p	4,093067269	6,666985586	4,461124494	4,510350995
T_i	5,45457994	1,85947075	7,085438439	5,486201108
T_d	0,419496743	0,387333623	0,405342655	0,450033577
T_a				0,221127185
N	38,77162427	12,66112324	37,75043961	0,716253287
α				1,104977553
Phase margin	64.2068	59.5003	62.5304	60.1423
Gain Margin	2.1198	2.2502	2.0975	1.8201

Disturbance Rejection Optimization

	Controllers	
Parameters	PID	PIDA
Controller Transfer Function	$C(s) = \frac{5.2 s^2 + 11.02 s + 6.588}{0.0001673 s^2 + 1.673 s}$	$C(s) = \frac{468.3 s^4 + 1069.0 s^3 + 794.8 s^2 + 131.8 s + 6.194}{0.01477 s^4 + 147.7 s^3 + 29.9 s^2 + 1.513 s}$
IAE	0,319465241	0,321087596
K_p	6,58829534	6,193530397
T_i	1,672981486	1,513019687
T_d	0,471706625	0,511678613
T_a		6,260623614
N	4717,066247	5116,786127
α		0,633576281
Phase margin	32.5868	32.7936
Gain Margin	1.3641	1.3548