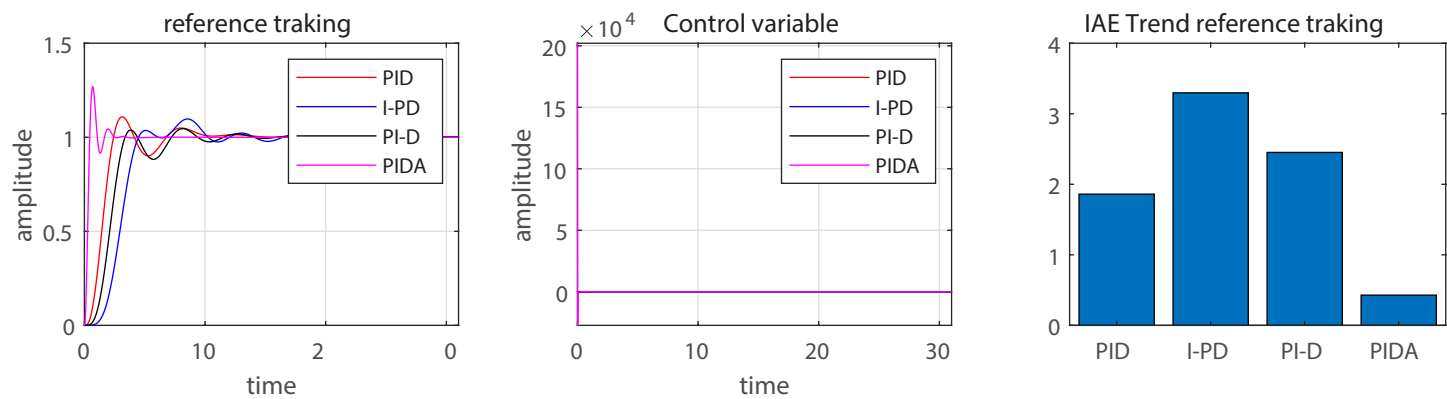


Multiple Equal Poles

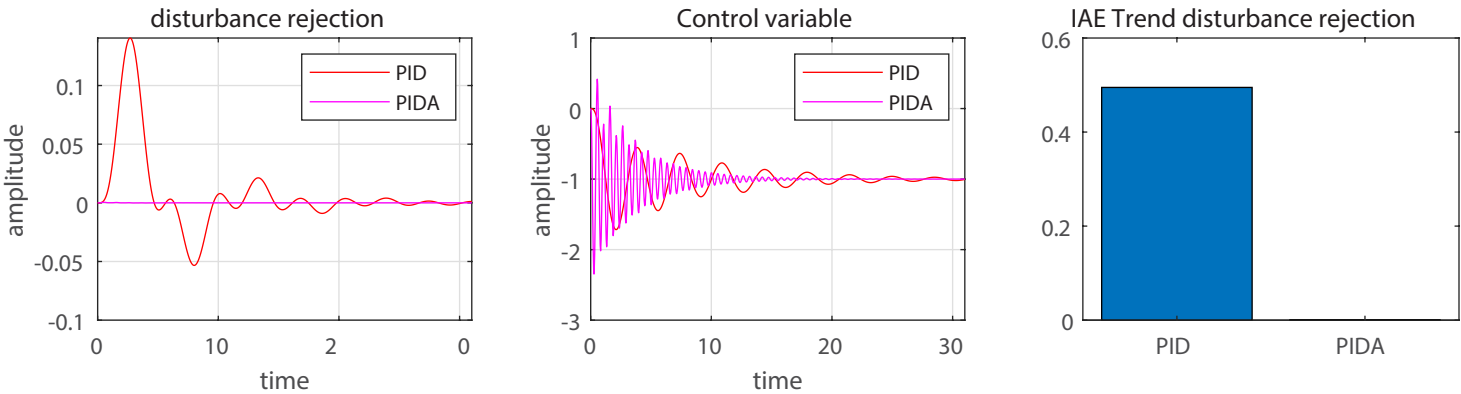
$$G(s) = \frac{1}{(1 + s)^4}$$

Set Point Optimization



	Controllers			
Parameters	PID	I-PD	PI-D	PIDA
Controller Transfer Function	$C(s) = \frac{9.976 s^2 + 6.582 s + 2.221}{0.03694 s^2 + 2.951 s}$	$C_1(s) = \frac{2.266}{s}$ $C_2(s) = \frac{5.8 s + 5.096}{0.01114 s + 1.0}$	$C_1(s) = 3.3523$ $C_2(s) = \frac{0.4593}{s}$ $C_3(s) = \frac{4.288 s}{0.01136 s + 1.0}$	$C(s) = \frac{33.26 s^4 + 92.11 s^3 + 135.7 s^2 + 85.86 s + 21.42}{0.0001646 s^4 + 0.03023 s^3 + 1.428 s^2 + 3.614 s}$
IAE	1,86019015	3,29662604	2,45194072	0,428337809
K_p	2,22139715	5,09621614	3,35230048	21,41667326
T_i	2,95058497	2,2491231	7,29901657	3,614138354
T_d	1,50957956	1,12701755	1,27919531	1,355353477
T_a				1,151688993
N	120,579985	101,174203	112,581389	3,633894232
α				104,2221126
Phase margin	59.1530	58.1288	69.3678	40.5777
Gain Margin	3.2491	2.5994	2.0305	7.5223

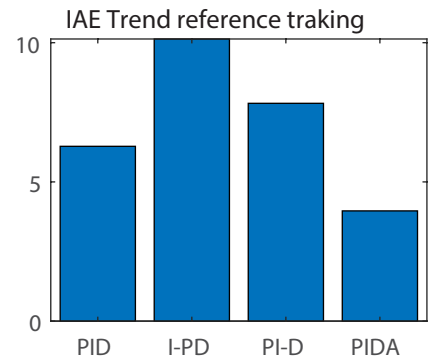
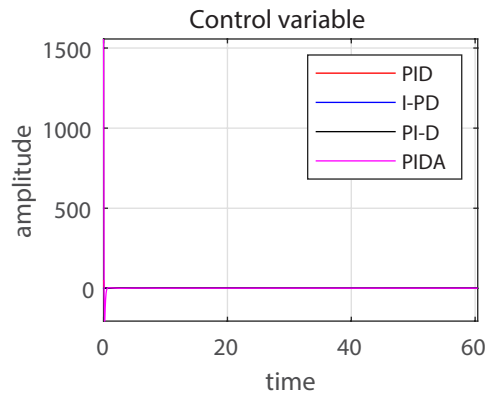
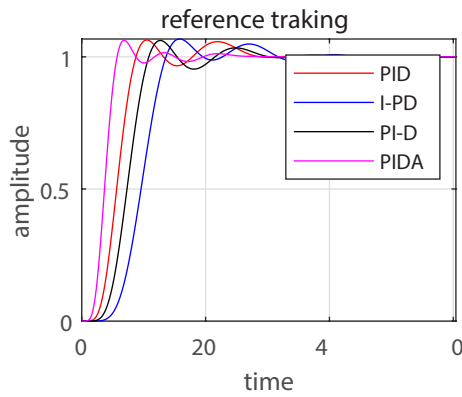
Disturbance Rejection Optimization



	Controllers	
Parameters	PID	PIDA
Controller Transfer Function	$C(s) = \frac{11.64 s^2 + 6.134 s + 5.171}{0.007024 s^2 + 1.18 s}$	$C(s) = \frac{6.379 s^4 + 13.59 s^3 + 209.5 s^2 + 150.6 s + 208.5}{2.914 e-6 s^4 + 0.0006374 s^3 + 0.03534 s^2 + 0.05279 s}$
IAE	0,49493553	0,000591112
K_p	5,17118574	208,5087277
T_i	1,180252291	0,052788404
T_d	1,901289735	18,13698334
T_a		0,887788038
N	319,4559054	27,8580706
α		96,41769598
Phase margin	11.2392	2.0049
Gain Margin	1.3320	1.1406

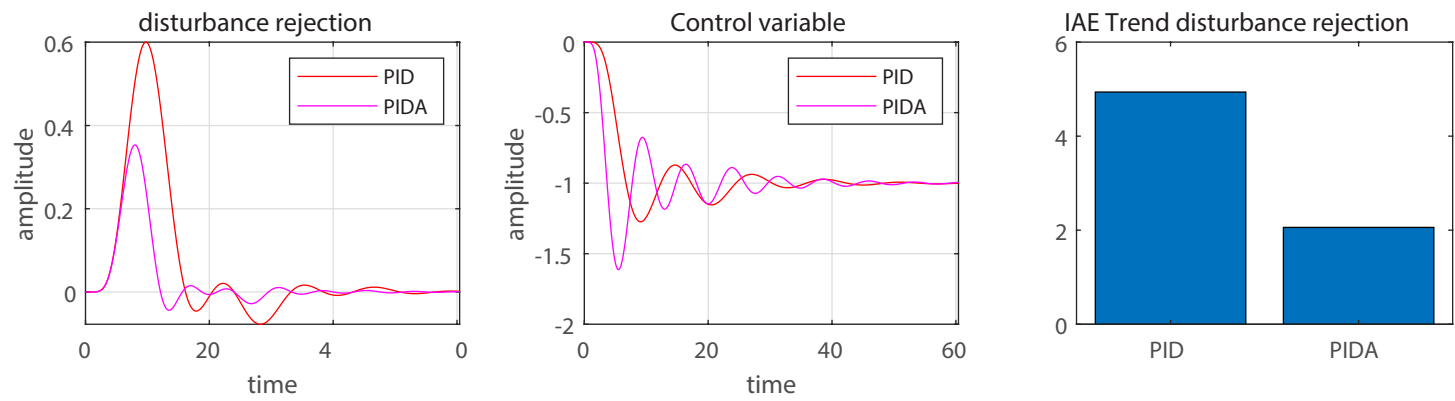
$$G(s) = \frac{1}{(1+s)^8}$$

Set Point Optimization



	Controllers			
Parameters	PID	I-PD	PI-D	PIDA
Controller Transfer Function	$C(s) = \frac{10.34 s^2 + 4.159 s + 0.8897}{0.1959 s^2 + 4.633 s}$	$C_1(s) = \frac{0.2517}{s}$ $C_2(s) = \frac{2.868 s + 1.269}{0.05096 s + 1.0}$	$C_1(s) = 0.9033$ $C_2(s) = \frac{0.1421}{s}$ $C_3(s) = \frac{2.057 s}{0.04759 s + 1.0}$	$C(s) = \frac{62.38 s^4 + 62.22 s^3 + 42.17 s^2 + 12.88 s + 1.737}{0.04008 s^4 + 1.082 s^3 + 7.771 s^2 + 6.152 s}$
IAE	6,277880471	10,1330807	7,82244652	3,95844953
K_p	0,889669486	1,26876863	0,903271164	1,73724034
T_i	4,632952243	5,0401914	6,358526489	6,15158044
T_d	2,467196892	2,20925055	2,277713359	2,6542542
T_a				5,2385362
N	58,35629582	43,3525888	47,86127125	2,3910478
α				68,3786343
Phase margin	61.7235	59.4700	62.3123	61.6754
Gain Margin	2.1815	2.3218	2.1347	2.2461

Disturbance Rejection Optimization



	Controllers	
Parameters	PID	PIDA
Controller Transfer Function	$C(s) = \frac{14.55 s^2 + 5.024 s + 1.156}{0.114 s^2 + 4.32 s}$	$C(s) = \frac{125.2 s^4 + 101.4 s^3 + 76.86 s^2 + 21.81 s + 3.285}{0.008846 s^4 + 0.4994 s^3 + 7.237 s^2 + 5.262 s}$
parametri	PID_DIST	PIDA_DIST
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IAE	4,937284438	2,058846387
K_p	1,155896791	3,285265538
T_i	4,320107233	5,262435143
T_d	2,887487826	3,052290444
T_a		5,552289657
N	109,4362925	2,34181803
α		154,603634
Phase margin	57.5868	32.5744
Gain Margin	1.5883	1.2977