ME 360: FUNDAMENTALS OF SIGNAL PROCESSING, INSTRUMENTATION, AND CONTROL

Experiment No. 6
Speed Control of a DC Electric Motor
Data Sheet

Simulation of Motor-generator System (15 pts.)

Test Case	V_{in} [V]	ω [rpm]	V_{gen} [V]
1	3		
2	4		
3	5		

V_{in} = input to motor ω = steady-state motor speed

Simulation of Motor-generator System with PI Speed Control (20 pts.)

Test Case		ω_{ref} [rpm]	K_P	K_I	T_{dist} [N-m]	ω_{out} [rpm]	V_{gen} [V]	t_{rise} (5 – 95%) [ms]	ω_{err} [rpm]
1	Open-loop	1000	1	0	0				
2	Closed-loop	1000	2	0	0				
3	Closed-loop	1000	2	0	0.02				
4	Closed-loop	1000	2	0	0.04				
5	Closed-loop	1000	4	0	0.04				
6	Closed-loop	1000	8	20	0.04				
7	Closed-loop	1000	8	50	0.04				
8	Closed-loop	1000	8	100	0.04				

ω_{ref} = set-point motor speed ω_{out} = steady-state motor speed ω_{err} = steady-state error = ω_{out} - ω_{ref}
K_P = Proportional gain K_I = Integral gain t_{rise} = rise time T_{dist} = Disturbance torque

Observations / Conclusions

Sketch the typical motor response with and without integral control. (5 pts.)

Testing the Motor-generator System with PI Speed Control (15 pts.)

Test Case		ω_{ref} [rpm]	K_P	K_I	ω_{out} [rpm]	V_{gen} [V]	ω_{err} [rpm]
1	Closed-loop	1000	4	0			
2	Closed-loop	1000	4	10			
3	Closed-loop	1000	4	20			
4	Closed-loop	1000	4	50			
5	Closed-loop	1000	8	10			

Sketch the motor response for Cases 2, 3 and 5 to show the effects of varying K_P and K_I (5 pts.)

Disturbance rejection (5 pts.)

Ask your TA to help you add a disturbance to the motor's shaft when the controller is running. Comment on how the motor reacts without and with integral control.

Integral Windup (5 pts.)

Sketch motor response with the integral windup problem. Why does this large overshoot occur?