

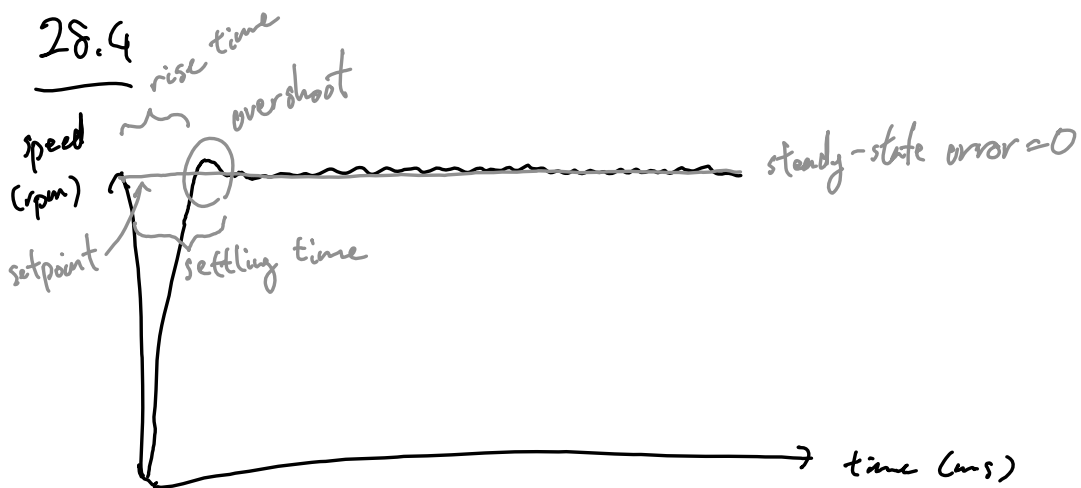
28.1

Assuming the system is first-order,

integral gain (I) contributes to instability

Derivative gain (D) contributes to stability

28.4



a) Decrease integrator gain slightly
(oscillation $\approx$ instability)

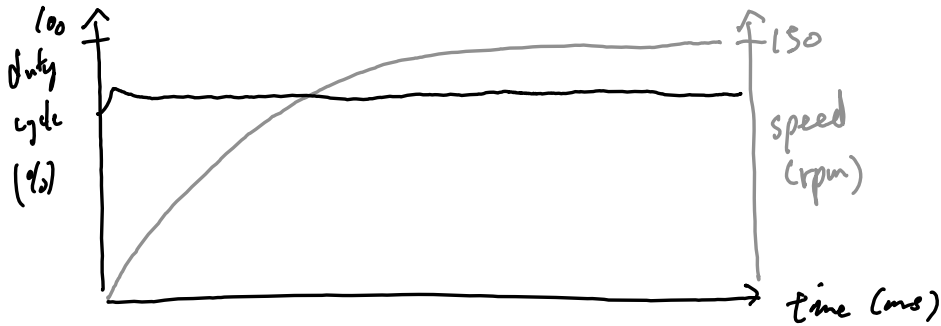
b) rise time stays the same.

overshoot decreases

settling time decreases

steady-state error stays the same (≈ 0)

28.5



- System can tolerate increased gain because duty cycle never reaches 100%
- Increase proportional gain to get 100% duty cycle at the beginning of transient response (but not all the time because system becomes nonlinear)

28.60

Rule of thumb:

$$\text{control period (ms)} \leq \frac{\text{mechanical time constant (ms)}}{7-10}$$

min. loop rate

$$= \text{max. period} = \frac{30 \text{ ms}}{7} \approx 4 \text{ ms, or } 250 \text{ Hz}$$

28.11 System must tolerate "swinging" of the output around the setpoint (or edges of the deadband)