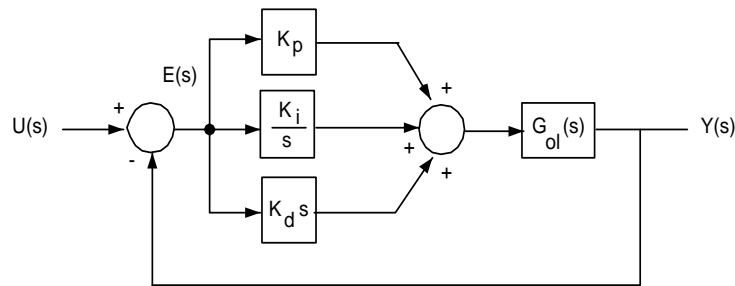


Homework – PID Theory and Motorized Prop Mount

1. Fill in the blanks (10-points)
 - A. Adding integral gain improves steady-state accuracy and the expense of _____
 - B. _____ gain improves stability at the expense of steady-state accuracy
 - C. PD gain improves stability _____ degrading accuracy much
 - D. _____ improves steady-state accuracy without degrading stability much
 - E. Type 1 and 2 systems have _____ error with step response
 - F. One adds an _____ to increase system type
 - G. One decreases system type by adding a _____
 - H. A 10-bit ADC provides decimal values from 0 to _____
 - I. _____ is the ratio of times when a signal is on and off
 - J. In DC motors, the back EMF and _____ constants are equal
2. Given below is a typical block diagram of a PID system.



Derive to show that the closed-loop transfer is given by (10-points)

$$G_{cl}(s) = \frac{Y(s)}{U(s)} = \frac{G_{ol}(K_p s + K_i + K_d s^2)}{s + G_{ol}(K_p s + K_i + K_d s^2)}$$

3. Recall that the Final Value Theorem states that $\lim_{t \rightarrow \infty} y(t) = \lim_{s \rightarrow 0} sY(s)$. Also, recall that the general form of an open-loop transfer function with $i = 0, 1, 2 \dots$ is given by

$$G_{ol}(s) = \frac{(\tau_a s + 1) \cdots (\tau_m s + 1)}{s^i (\tau_1 s + 1) \cdots (\tau_n s + 1)}$$

Derive to show that for proportional-only control that a Type 1 system response to a step input is $y_{ss} = 1$ (10-points)

4. In lab, the Technic, Axle Connector Double – Flexible Rubber (#45590) was introduced. Because it's flexible, a small motorized prop can fit inside it. If mounted on the Domabot, the motorized prop could blow out candles in front (bow-side) of the robot. In Studio construct a step-by-step build plan and BOM for a mount that attaches to the Domabot (10-points). Physically construct the mount and provide a photo of it attached to your Domabot (10-points) – if you don't have 45590, don't worry about it for the photo; the photo should show that it would allow the motorized prop to blow out candles that are in the front of the Domabot.