Homework – Wall-Following PID

1. Fill in the blanks (20-points)

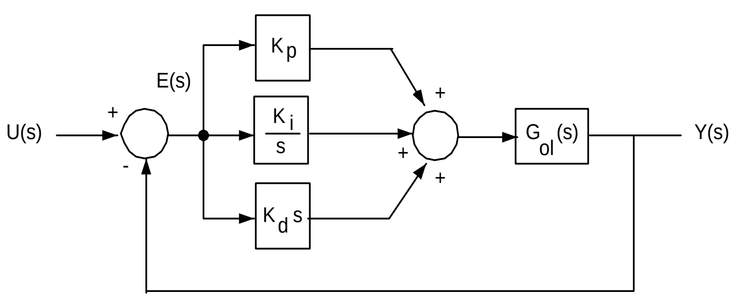
A. Adding integral gain improves steady-state accuracy and the expense of _____
B. _____ gain improves stability at the expense of steady-state accuracy
C. PD gain improves stability _____ degrading accuracy much
D. _____ improves steady-state accuracy without degrading stability much
E. Type 1 and 2 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. Write an NXC program called **`wfPidFile1_0a.nxc`** using best practices. The program will save portside-to-wall distance data into a file named "**`doma.csv`**". Recall the lab on Wall Following PID; Concept 2 had one capture wall distance data for 4 different proportional gains. Show your NXC code (10-points). You only need to show the code for a single gain case. Generate <u>your own</u> Excel graphs for:

kP	kI	kD	YouTube URL	Excel Plot
0	0	0		
1.5	0	0		
5	0	0		
15	0	0		

For reference, see the plots in Concept 2 of the lab. <u>Make sure</u> to: (1) title the graph with the correctly (i.e. gain values); (2) label both the horizontal and vertical axes; and (3) add minor gridlines (10-points for each graph; 4 plots total = 40 points). Observe your 4 plots. How does the rise time change and gain kP increases (5-points)? How does the steady-state error change as kP increases (5-points)? Grand total: 10+4*10+5+5 = 60-points

3. Given below is a typical block diagram of a PID system.



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

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

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