

**Quiz 7**  
**Lance Go**  
**February 24, 2022**

**1. Give pseudocode for a basic PID controller (without integrator anti-windup). There are functions `get_ref()` and `get_sensor()` to call, and you can make others if you want.**

**There are already global variables, and you can add more:**

```
static volatile float eint = 0;
static volatile float eprevious = 0;
static volatile float ediff = 0;

__ISR(timer at 1kHz) {
    ref = get_ref();
    sensor = get_sensor();
    error = ref - sensor;
    ediff = error - eprevious;
    eint = error + eint;
    u = Kp*error + Ki*eint + Kd * ediff;
    eprevious = error;
    control(u);
    interrupt_flag = 0;
}
```

**2. Explain what integrator anti-windup is:**

If the integrator is allowed to build up to a very high value, the system can create a response that has too much error in the opposite direction. This can create oscillations in the system. To prevent a build up from happening, integrator anti-windup can be used. Integrator anti-windup is a limit that can be put on the integrator term to stop the integrator before it builds too much.

**3. You have picked  $K_p$ ,  $K_i$ , and  $K_d$  gains.**

**(a) The response has too much overshoot. Which gain could you increase to reduce the overshoot?**

$K_d$

**(b) The response has too much overshoot. Which gain could you decrease to reduce the overshoot?**

$K_p$

**(c) The response has the right overshoot and settling time characteristics, but too much steady-state error. Which gain could you increase to reduce the steady-state error?**

$K_i$