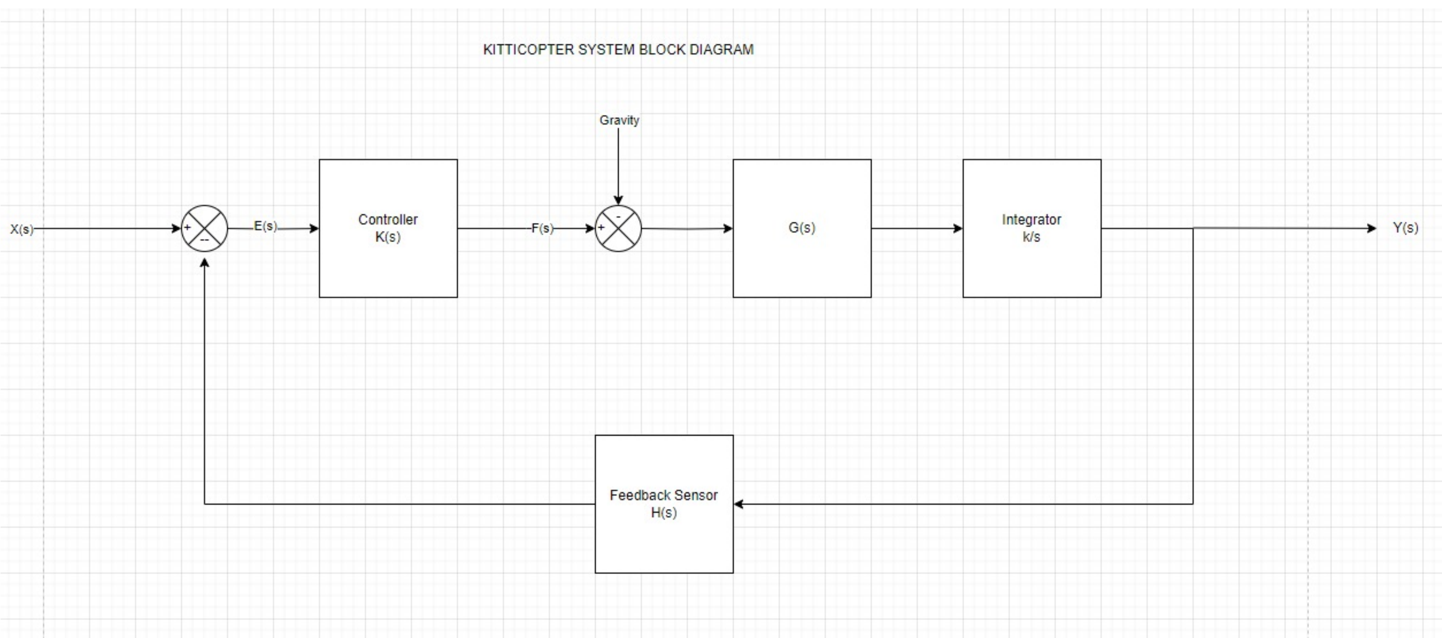
LAB 2 PRE-LAB

Travimadox Webb

Student No: WBBTRA001

A. Block Diagram

Below is the block diagram representing the system.



B. Differential Equation

To describe the system, we use Newton's Second Law of Motion:

$$F = ma \implies F = my''(t) \implies F_T(t) - by'(t) - mg = y''(t)$$

Where:

- $F_T(t)$ is the thrust
- b is the aerodynamic drag coefficient
- g is acceleration due to gravity
- m is mass

C. Transfer Function

I. Velocity & Thrust of Kitticopter

The governing differential equation can be rewritten as:

$$v'(t) = F_T(t) - bv(t) - g$$

Applying the Laplace transform, we get:

$$sV(s) = F(s) - bV(s) - \frac{g}{s} \implies (s+b)V(s) = F(s) - \frac{g}{s}$$

$$V(s) = \frac{1}{s+b}F(s) - \frac{1}{s+b}\frac{g}{s}$$

The transfer function $G(s)$ therefore is:

$$G(s) = \frac{1}{s+b}$$

II. Closed-Loop Transfer Function

The closed-loop transfer function becomes:

$$G_{cl}(s) = \frac{K}{s^2 + bs + KH}$$

D. Steady-State Errors and Performance Metrics

I. Position Error in Relation to Setpoint

The error $e(s)$ can be described as:

$$e(s) = X(s) - \frac{KGHe(s)}{s} \implies E_{ss} = \frac{1}{1 + \frac{KH}{s^2+bs}}$$

After simplification:

$$E_{ss} = \frac{s^2 + bs}{s^2 + bs + KH}$$

Type number: 0

Tracking Performance: Finite error using a proportional controller

II. Impact of Gravity on Position Output

Setting $X(s) = 0$ and letting gravity act as $V(s)$, we have:

$$Y(s) = \frac{Q}{1 + QKH} V(s)$$

After inserting the values:

$$G_{gravity}(s) = \frac{K}{s^2 + bs + KH}$$

Type number: 0

Effect of Gravity: Finite input disturbance effect using a proportional controller