EENG307 Unit 2: Lecture Summaries

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The Lecture 15 Example has the following closed-loop system:

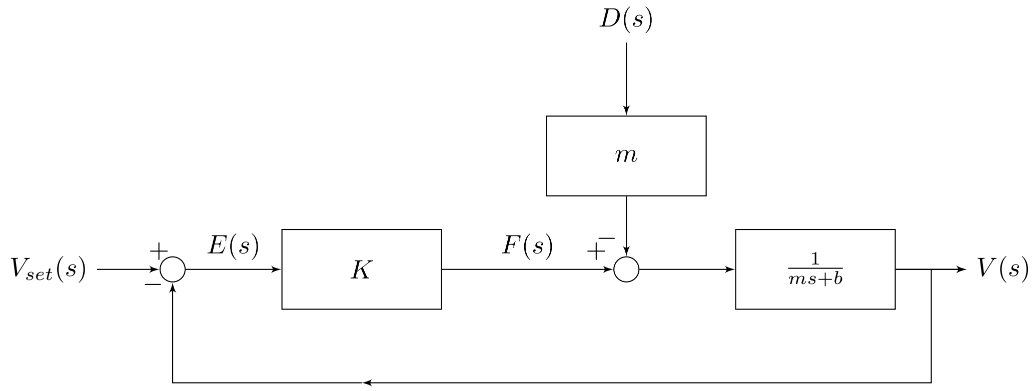

Figure 1: Lecture 15 Block Diagram from Example

The block with transfer function $\frac{1}{ms+b}$ is our plant $G(s)$. The K block is our proportional controller. $F(s)$ is the force of the motor that we control. $D(s)$ is the disturbance force of gravity when we go up a hill.

We will simplify the block diagram using algebra. We start with these three equations from our block diagram.

1. $V(s) = G(s)(F(s) + mD(s))$
2. $F(s) = KE(s)$
3. $E(s) = V_{set}(s) - V(s)$

Plug 3 into 2 so:

$$F(s) = K(V_{set}(s) - V(s))$$

Plug $F(s)$ into 1 so:

$$V(s) = G(s)[K(V_{set}(s) - V(s)) + mD(s)]$$

Move terms with $V(s)$to LHS

$$V(s)(1 + KG(s)) = KG(s)V_{set}(s) - G(s)mD(s)$$

Divide both sides by $1 + KG(s)$

$$V(s) = \frac{KG(s)}{1 + KG(s)}V_{set}(s) - \frac{mG(s)}{1 + KG(s)}D(s)$$

Plug in $G(s) = \dfrac{1}{ms+b}$and Simplify

$$V(s) = \frac{K}{ms+b+K}V_{set}(s) - \frac{m}{ms+b+K}D(s)$$

$V(s)$ is the velocity impacted by both the motor force input and disturbance input. The term $\frac{K}{ms+b+K}V_{set}(s)$ is the impact of the input desired velocity $V_{set}(s)$ on our output $V(s)$. The term $\frac{m}{ms+b+K}D(s)$ is the change in the car velocity $V(s)$ (slow down) due to the slope of a hill $D(s)$.

Where this is no disturbance, $D(s) = 0$ then the car velocity (due to the input reference) is given by $V(s) = \frac{K}{ms+b+K}V_{set}(s)$. When there is no reference input $V_{set}(s) = 0$ then the car velocity (due to the disturbance input) is given by $V(s) = \frac{m}{ms+b+K}D(s)$.