

# EENG307: Disturbances and Steady State Error<sup>1</sup>

## Lecture 15

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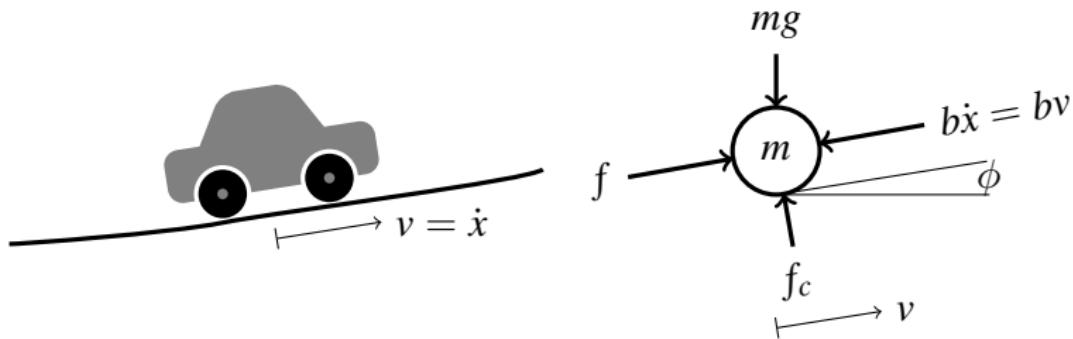
Fall 2022

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<sup>2</sup>Developed and edited by Tyrone Vincent and Kathryn Johnson, Colorado School of Mines, with contributions from Salman Mohagheghi, Chris Coulston, Kevin Moore, CSM and Matt Kupilik, University of Alaska, Anchorage < >

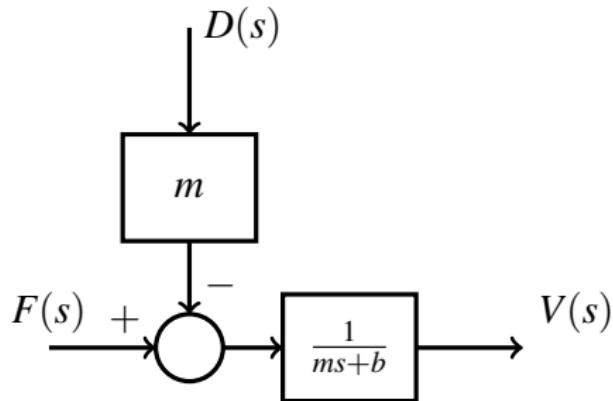
# Cruise Control



$$m\ddot{x} = f - b\dot{x} - mg \sin(\phi)$$

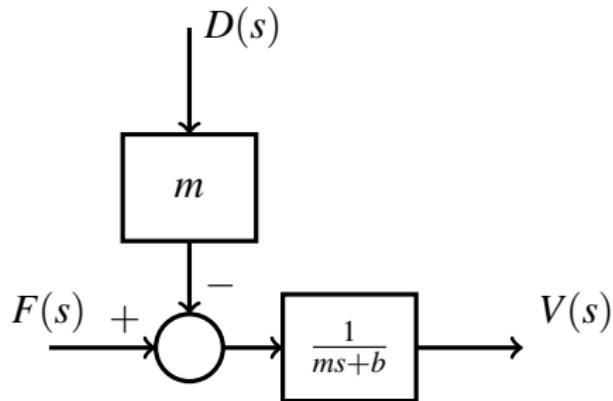
$$m\dot{v} + bv = f - f_d$$

# System block diagram



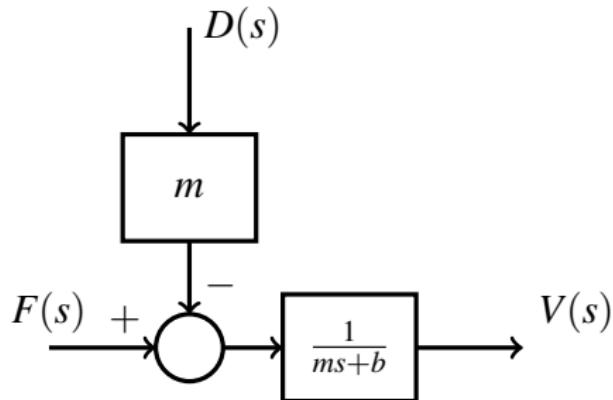
- Suppose the motor supplies a constant force  $f_m$  on a flat road. At steady state, what will the car's speed be?
- Suppose the car is at steady state on a flat road, but then drives on an incline with slope  $\phi$ . By how much will the car slow down?

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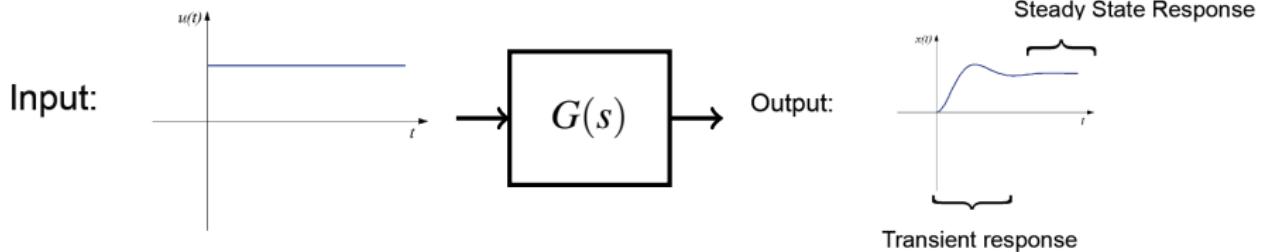
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# Steady State

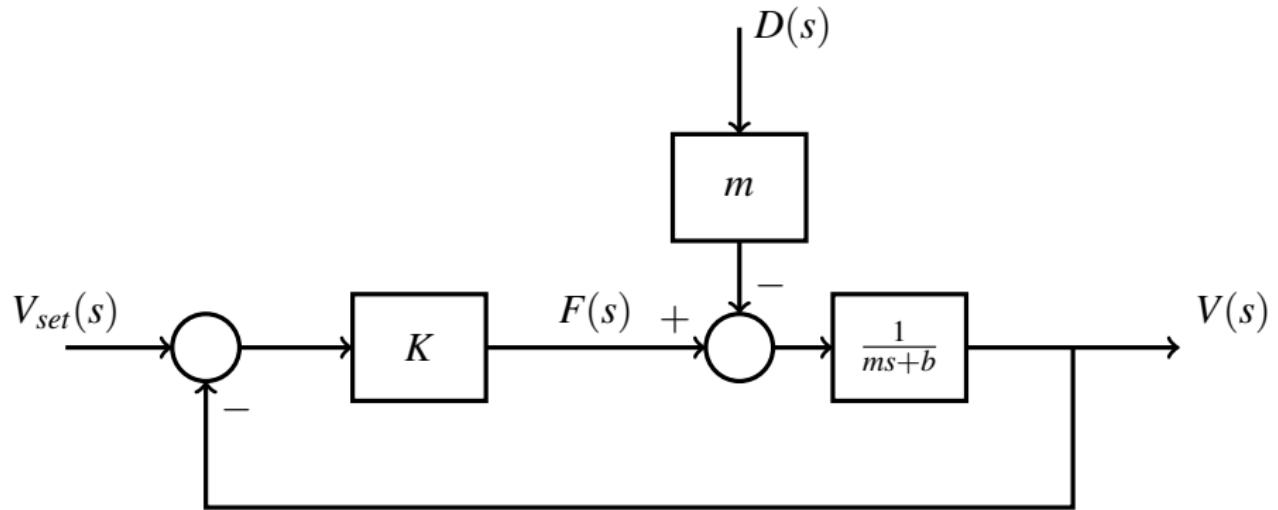


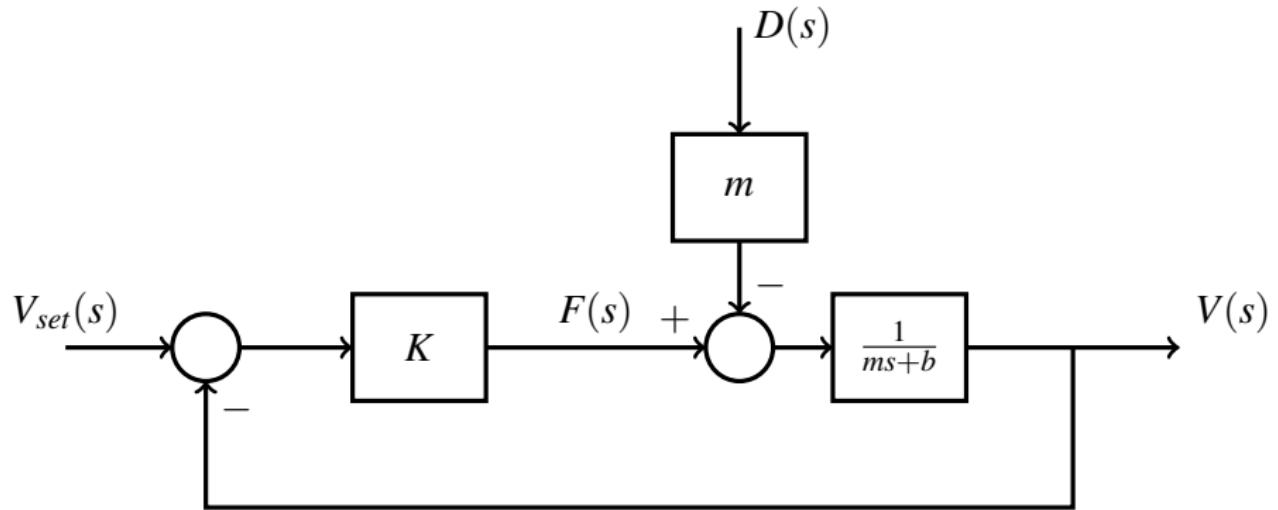
## Theorem

*Given the signal  $Y(s)$  such that  $sY(s)$  has all poles with negative real part. Then the inverse Laplace transform  $y(t)$  satisfies*

$$\lim_{t \rightarrow \infty} y(t) = \lim_{s \rightarrow 0} sY(s)$$







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