

# Feedforward Speed Control

Course 1, Module 5, Lesson 3



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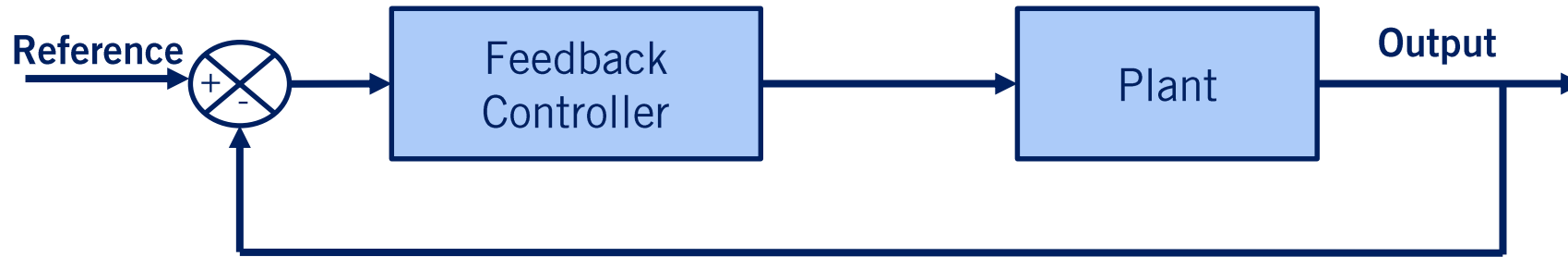
# Learning Objectives

In this video, you will ...

- Integrate both feedforward and feedback control into a combined control architecture
- Apply this architecture to longitudinal vehicle control

# Feedback vs. Feedforward Control

## Feedback - Closed Loop

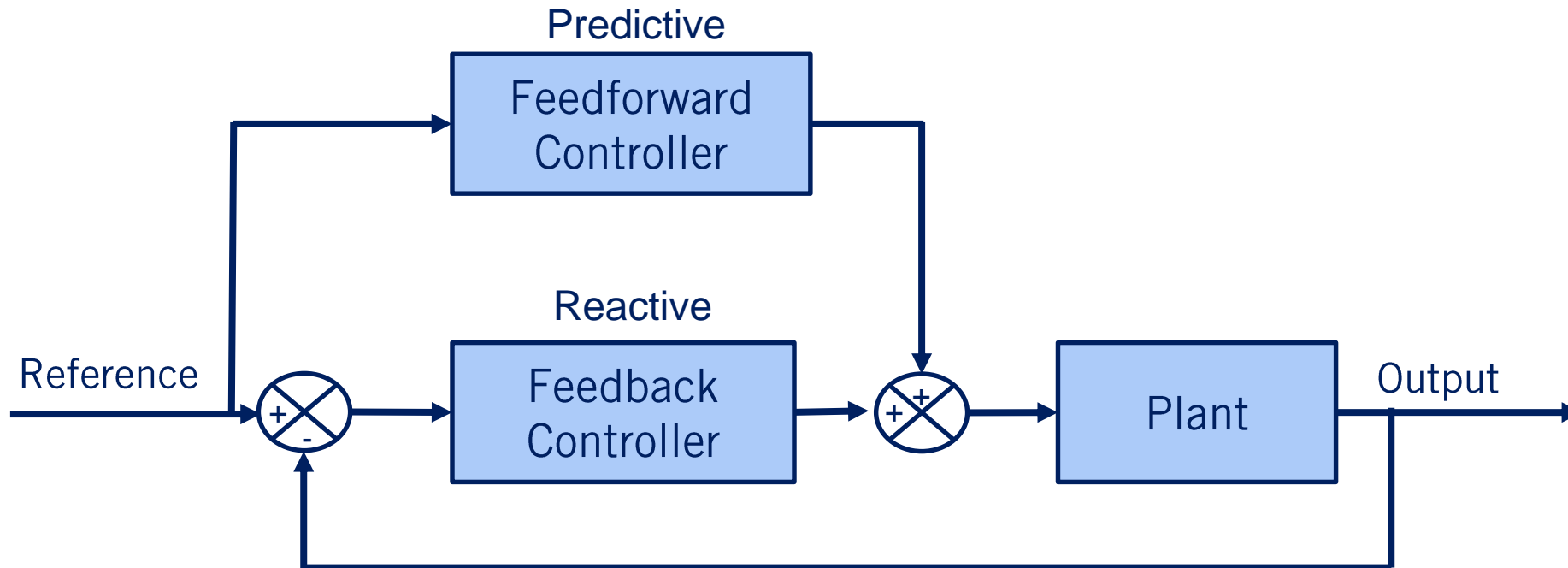


## Feedforward - Open Loop



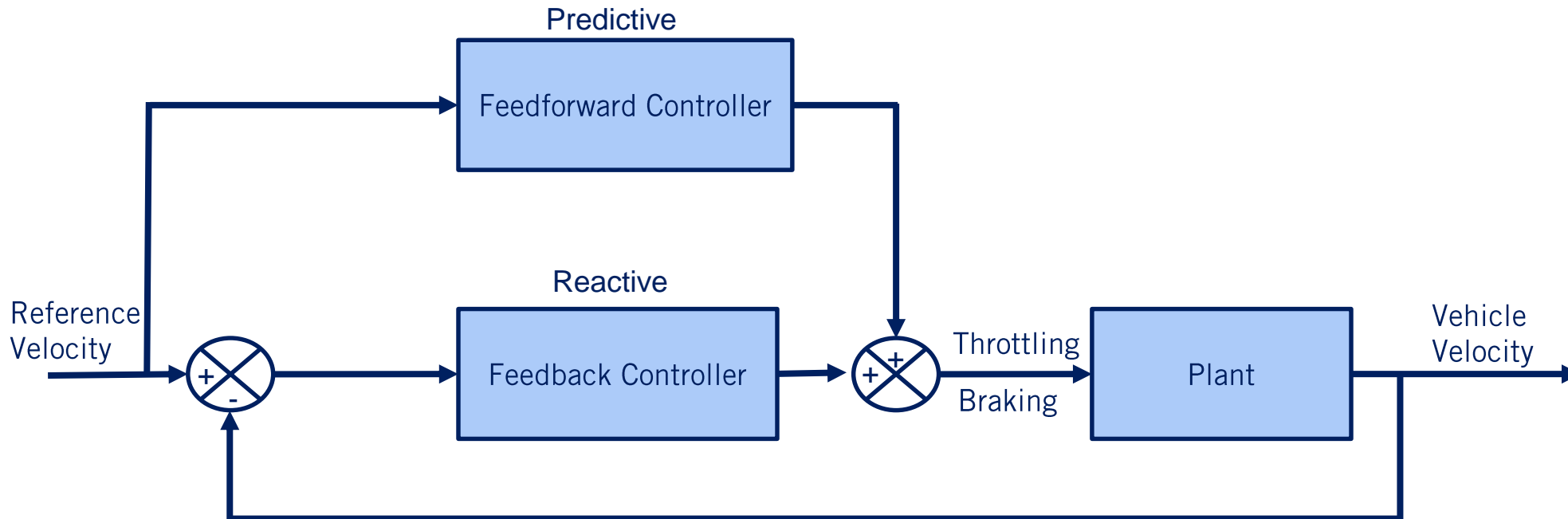
# Combined Feedforward and Feedback Control

- Feedforward and feedback are often used together:
  - Feedforward controller provides predictive response, non-zero offset
  - Feedback controller corrects the response, compensating for disturbances and errors in the model



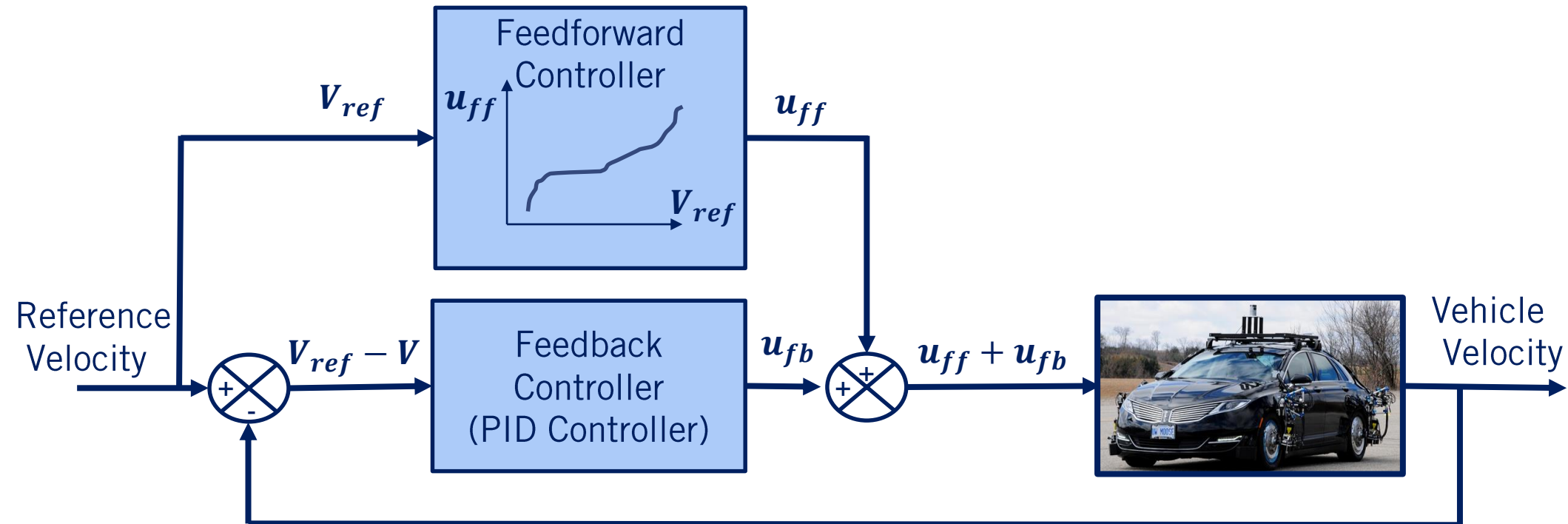
# Vehicle Speed Control

- Throttling & Braking:
  - The output of the feedforward and feedback control blocks are the throttling or braking signals to accelerate or decelerate the vehicle (plant) to keep the vehicle velocity close to the reference velocity.

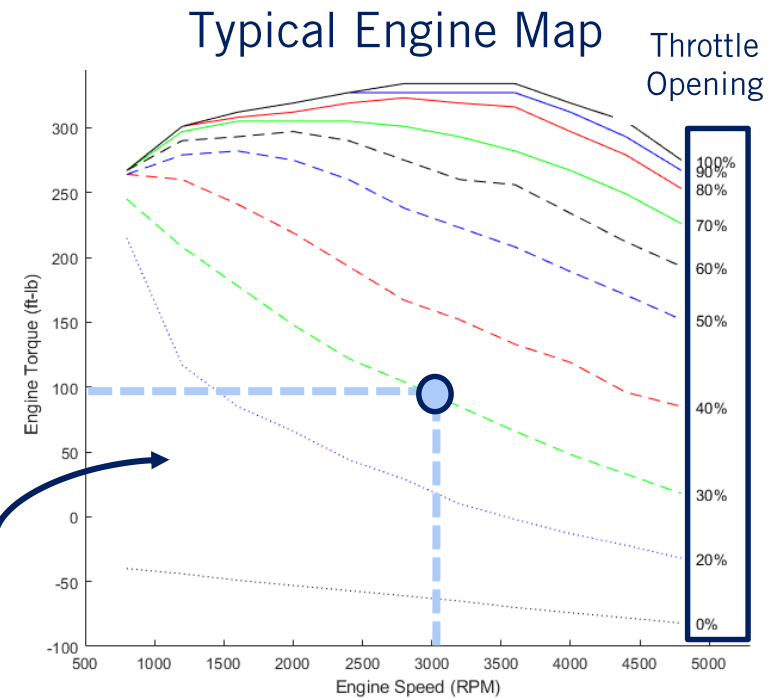
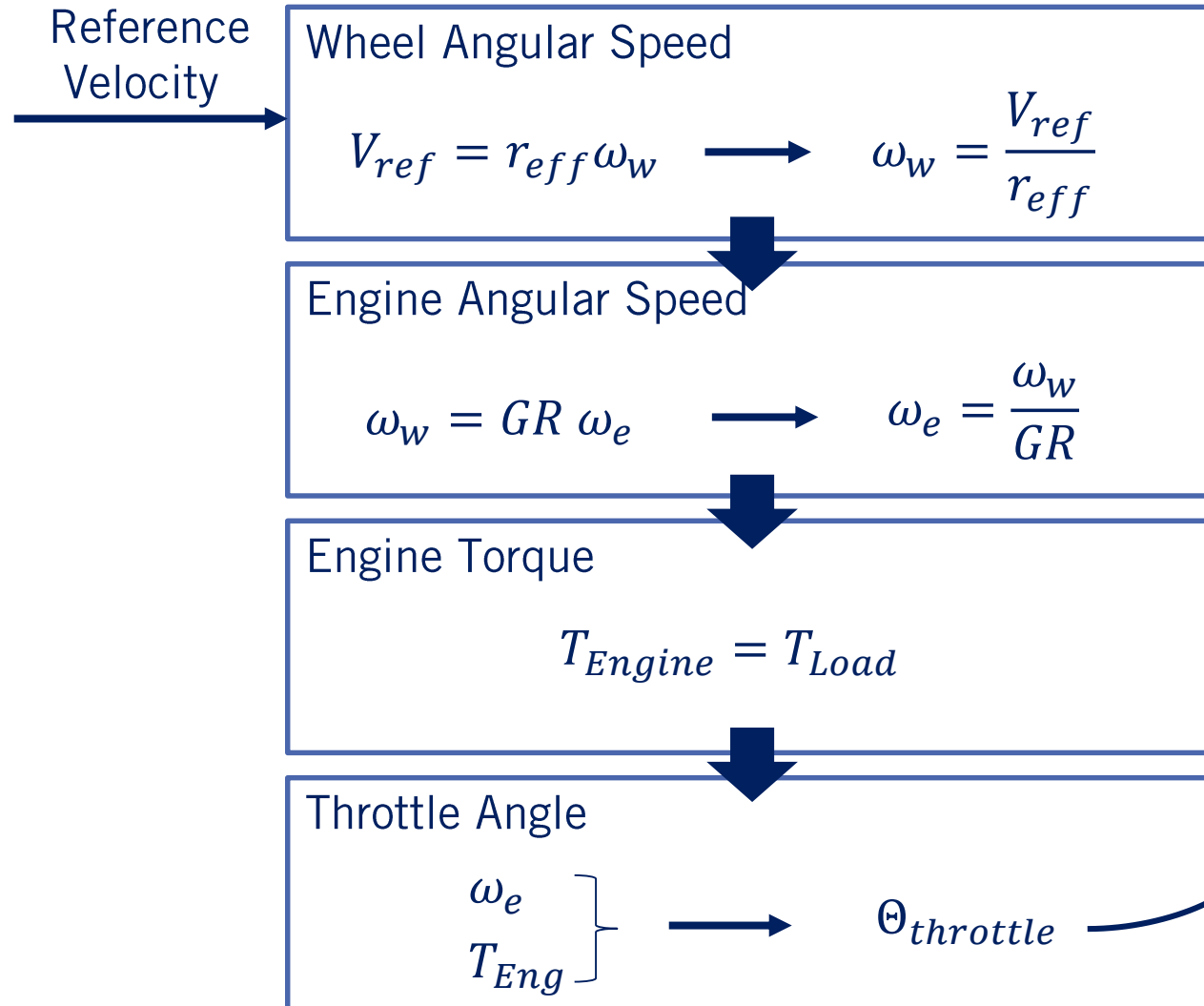


# Controller Actuators

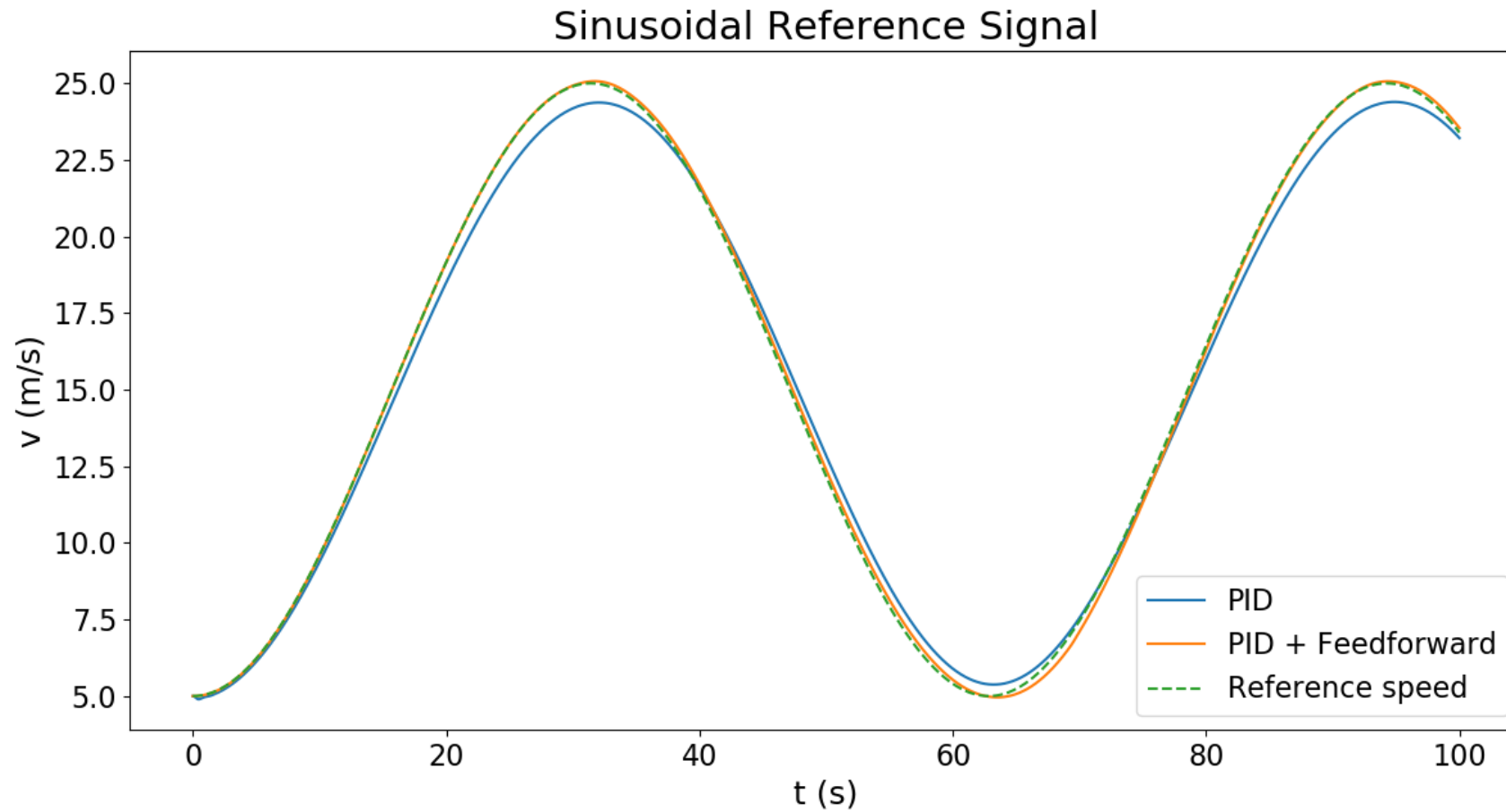
- Actuators (throttle angle):
  - The feedforward controller generates the actuator signal ( $u_{ff}$ ) based on the predefined table and the feedback controller generates the actuator signal ( $u_{fb}$ ) based on the velocity error.



# Feedforward Table



# Feedforward Simulation Results



# Summary

What we have learned from this lesson:

- Add feedforward control for improved reference tracking
- Apply feedback and feedforward loops for autonomous vehicle speed control

# Summary

What we have learned from this module:

- Reviewed the concepts of classical control, and defined the PID controller
- Built a PID controller for longitudinal control of a car
- Applied feedforward control to improve reference speed tracking

What is next?

- In the next module, we will study lateral vehicle control