Longitudinal Speed Control with PID

Course 1, Module 5, Lesson 2

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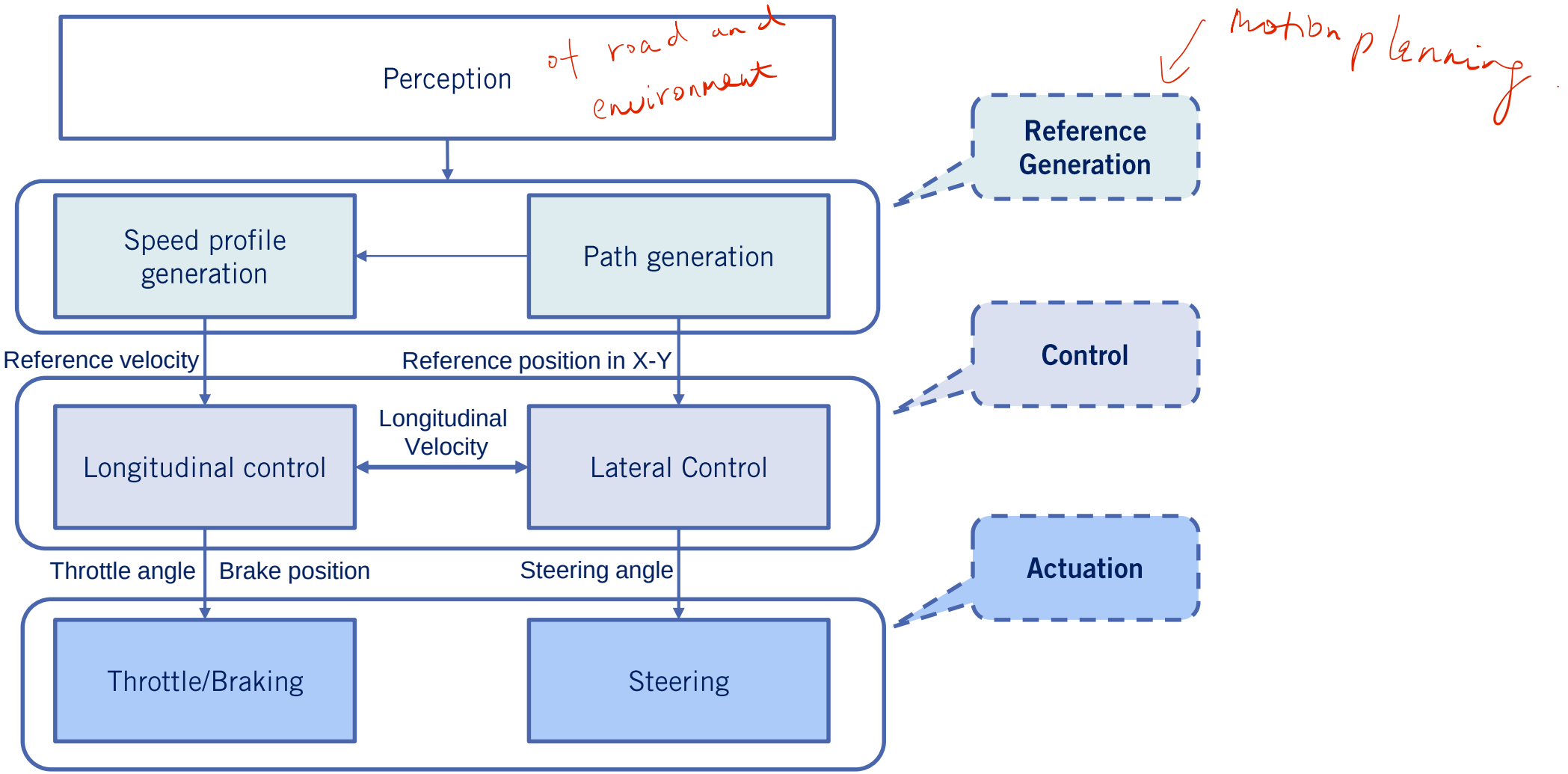
Learning Objectives

In this video, you'll …

- Define the full vehicle planning and control architecture
- Design a PID controller for cruise control/speed regulation

Architecture of Vehicle Control Strategy

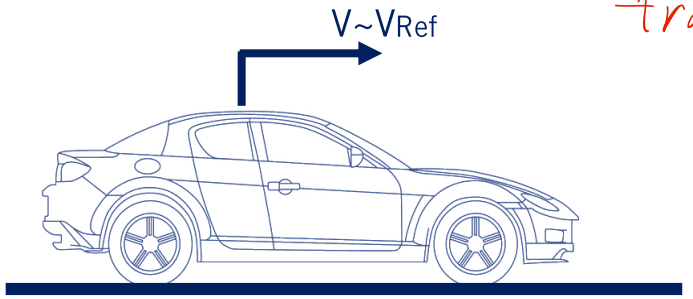


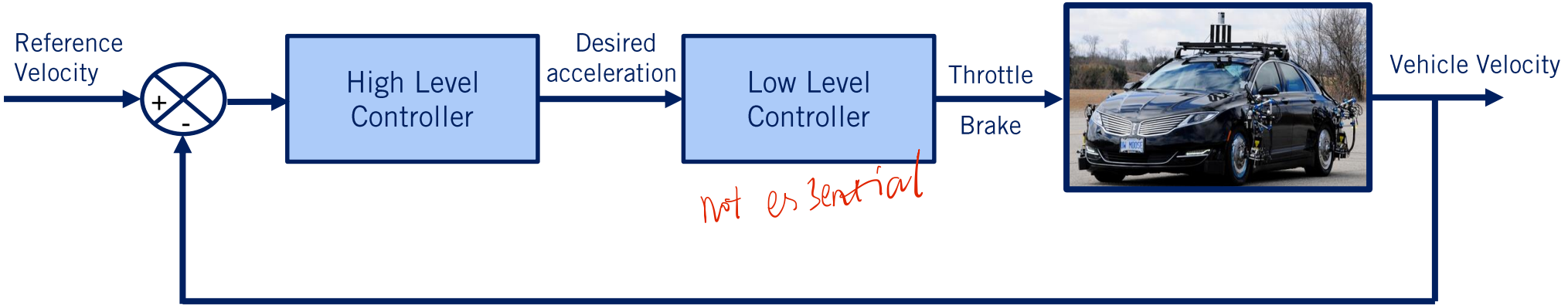
Longitudinal Speed Control

Extension:
adaptive cruise control
traffic jam assist

Cruise control:

- Speed of the vehicle is controlled (by throttling and braking) to be kept at the reference speed





not essential

Upper Level Controller

- Determines the desired acceleration for the vehicle (based on the reference and actual velocity).

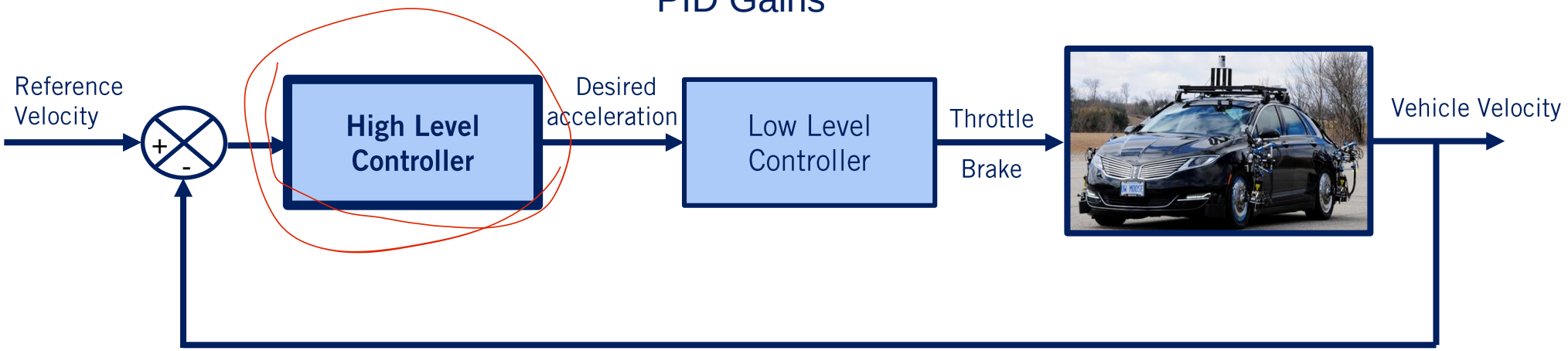
Desired Acceleration

Reference Velocity

Vehicle Velocity

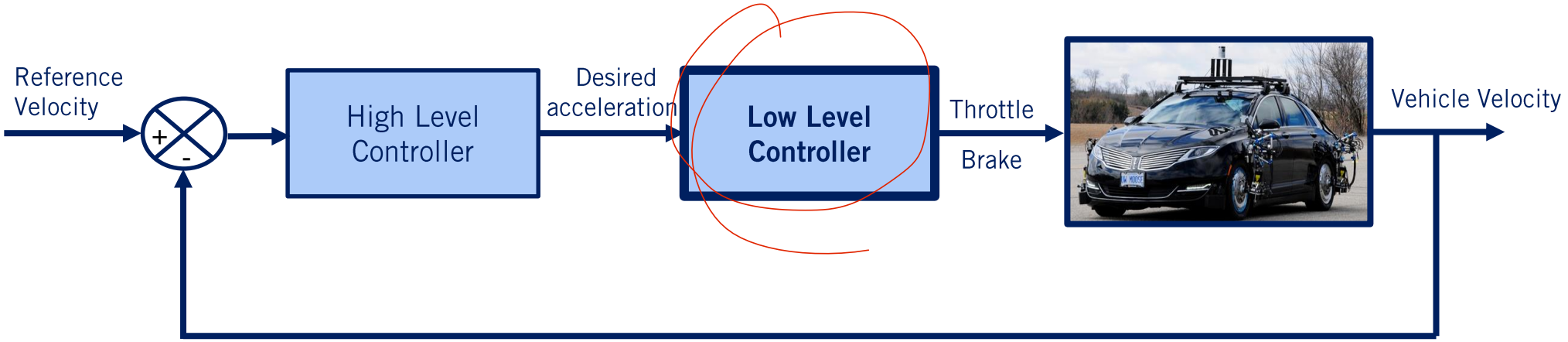
$$\ddot{x}_{des} = K_P\left(\dot{x}_{ref} - \dot{x}\right) + K_I \int_0^t \left(\dot{x}_{ref} - \dot{x}\right)dt + K_D \frac{d\left(\dot{x}_{ref} - \dot{x}\right)}{dt}$$

PID Gains

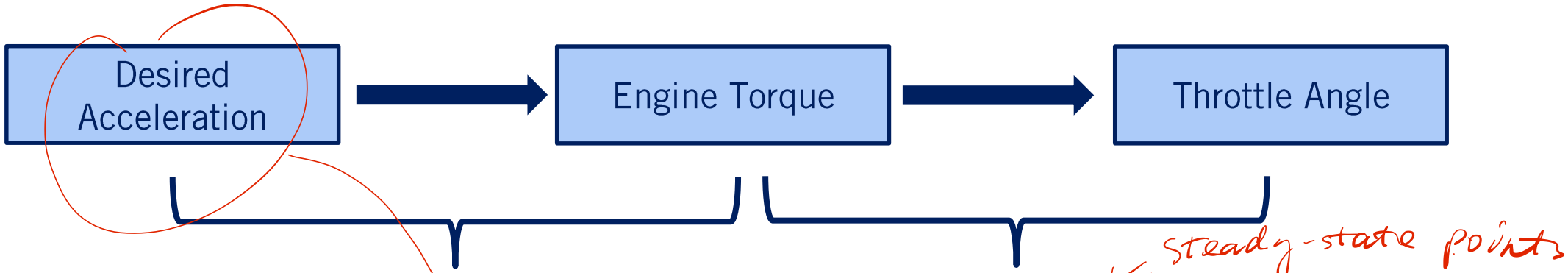


Lower Level Controller

- Lower Level Controller:
  - Throttle input is calculated such that the vehicle track the desired acceleration determined by the upper level controller
- Assumptions:
  - Only throttle actuations is considered (no braking)
  - The torque converter is locked (gear 3+) gear 3 or higher
  - The tire slip is small (gentle longitudinal maneuvers)



Lower Level Controller

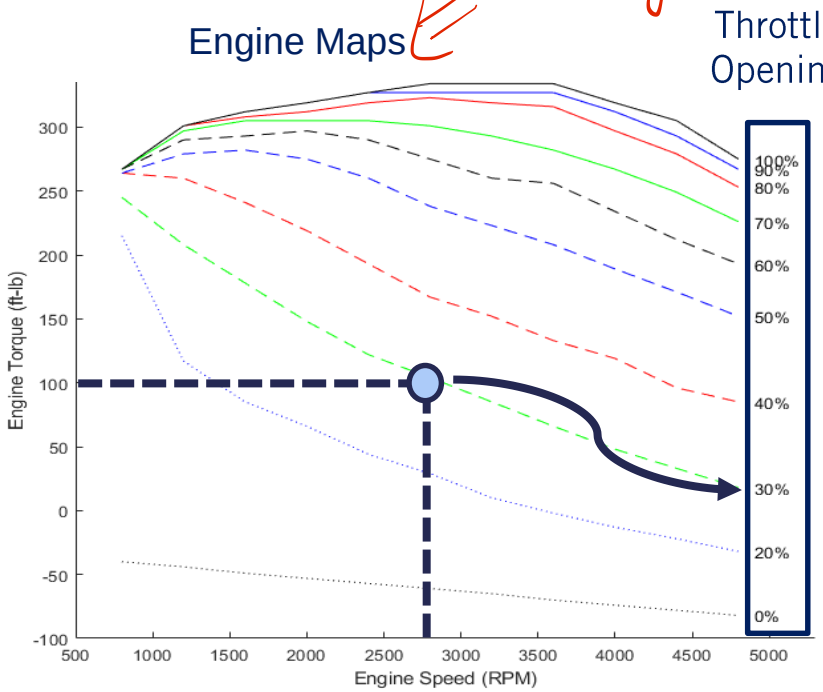


Vehicle Drivetrain Dynamics
(Previous Module)

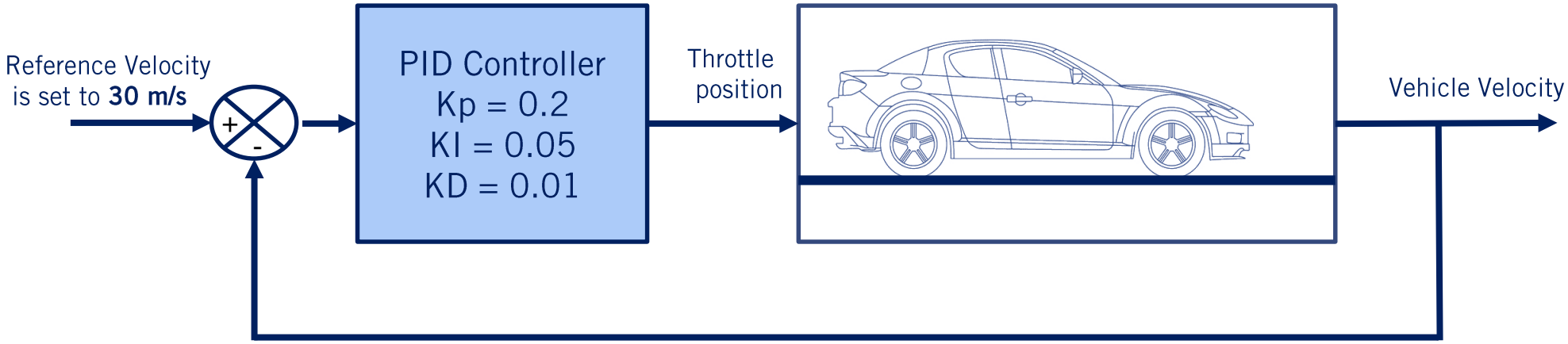
$$T_{Engine} = \frac{J_e}{(r_{eff})(GR)} \ddot{x}_{des} + T_{Load}$$

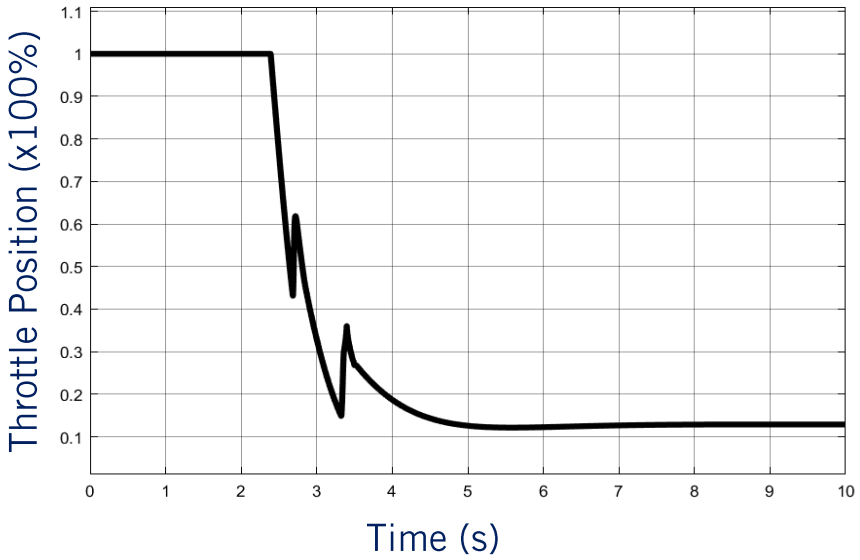
steady-state points

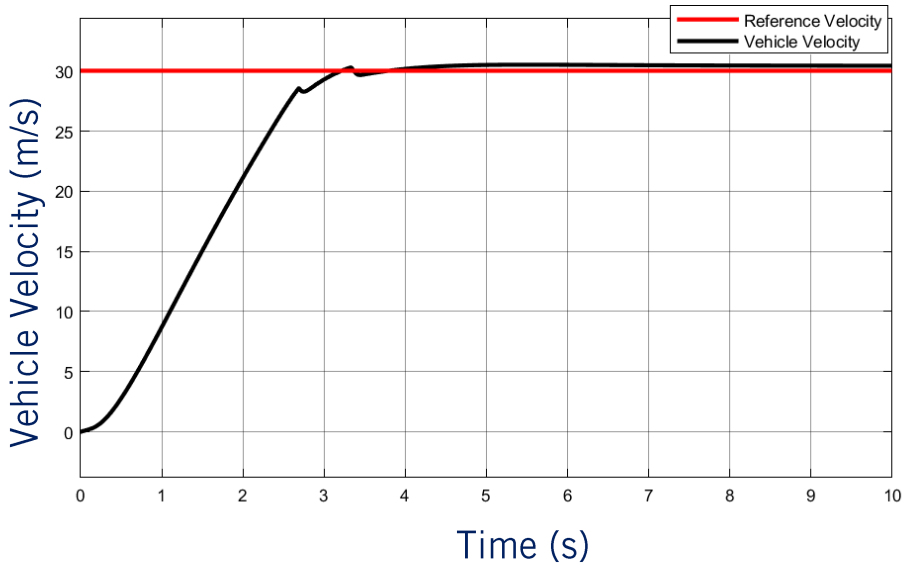
Engine Maps



Simulation Example







Summary

What we have learned from this lesson:

- Vehicle longitudinal cruise control
- High and low-level control structure based on PID and engine maps

What is next?

- We will go through the vehicle feedforward control design