

Vehicle Actuation

Course 1, Module 4, Lesson 6

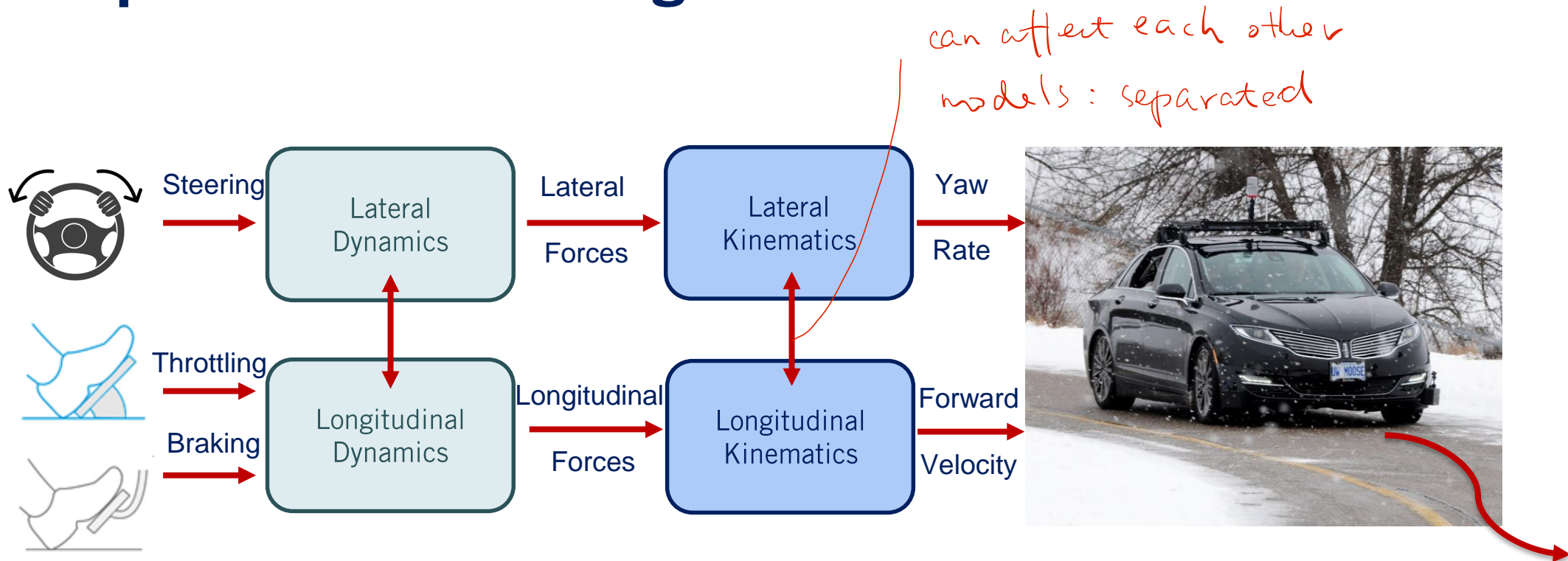


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Learning Objectives

- Build models for the main vehicle actuation systems such as steering, throttling, and braking
- Connect these models to longitudinal and lateral vehicle dynamic models

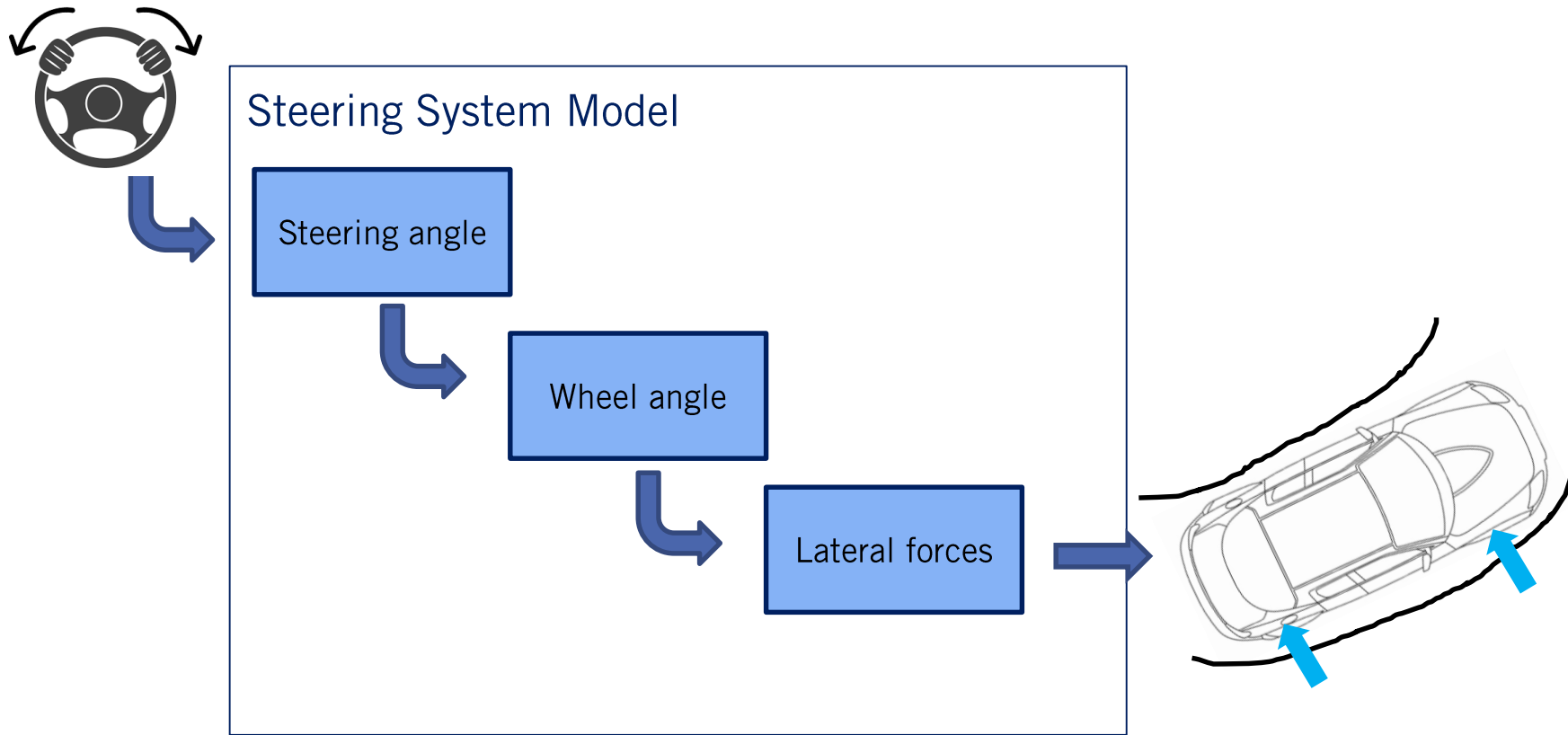
Coupled Lateral & Longitudinal



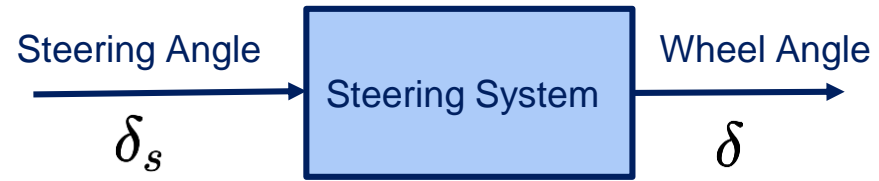
Main Control Task:

To keep the vehicle on the defined path at the desired velocity

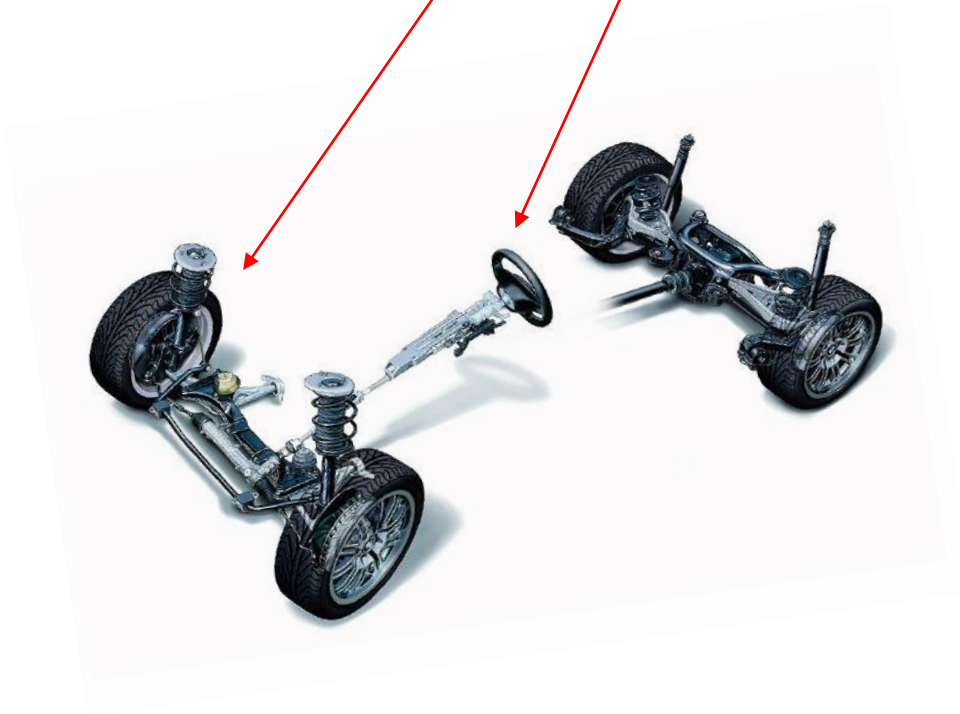
Steering



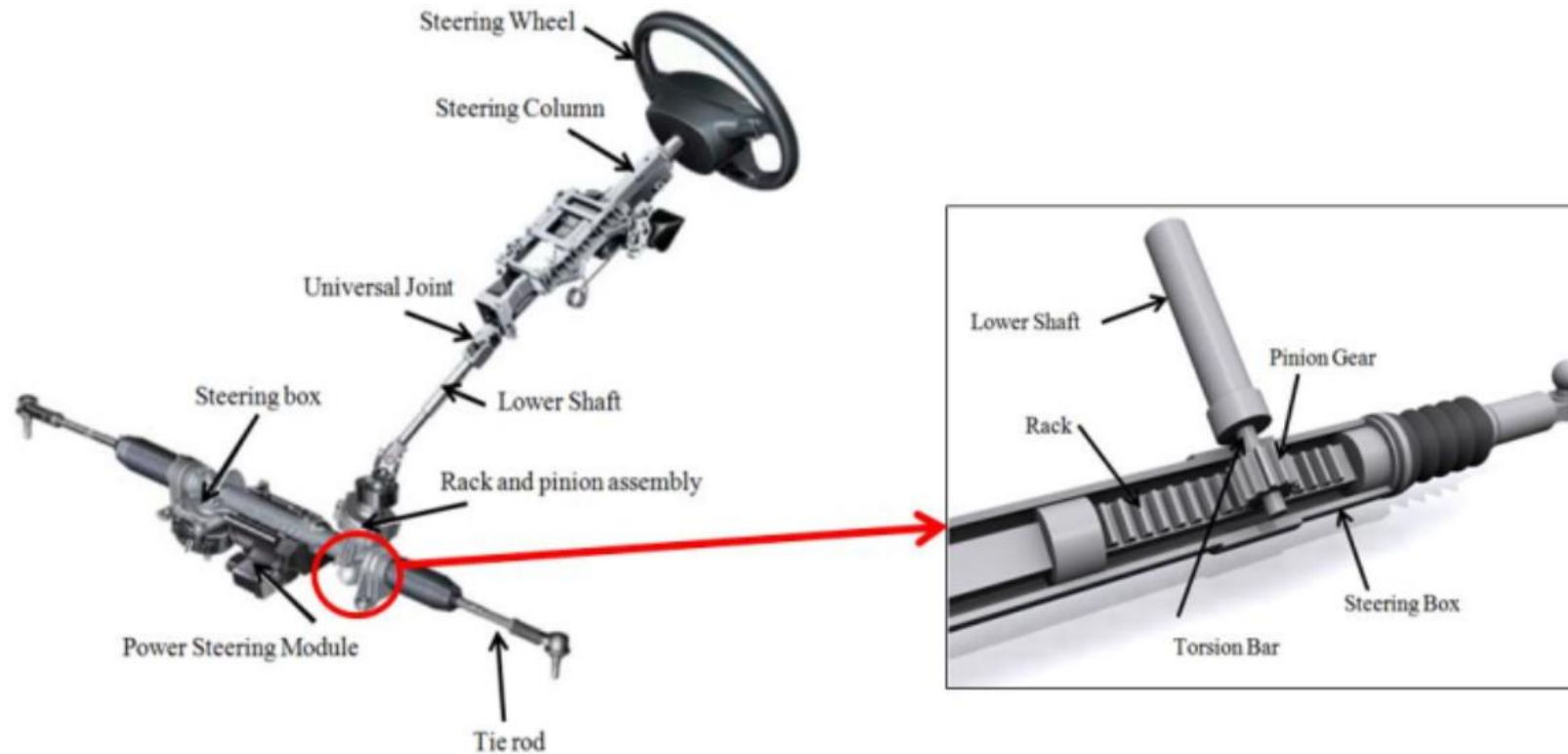
Simple Steering Model



$$\delta = c\delta_s$$

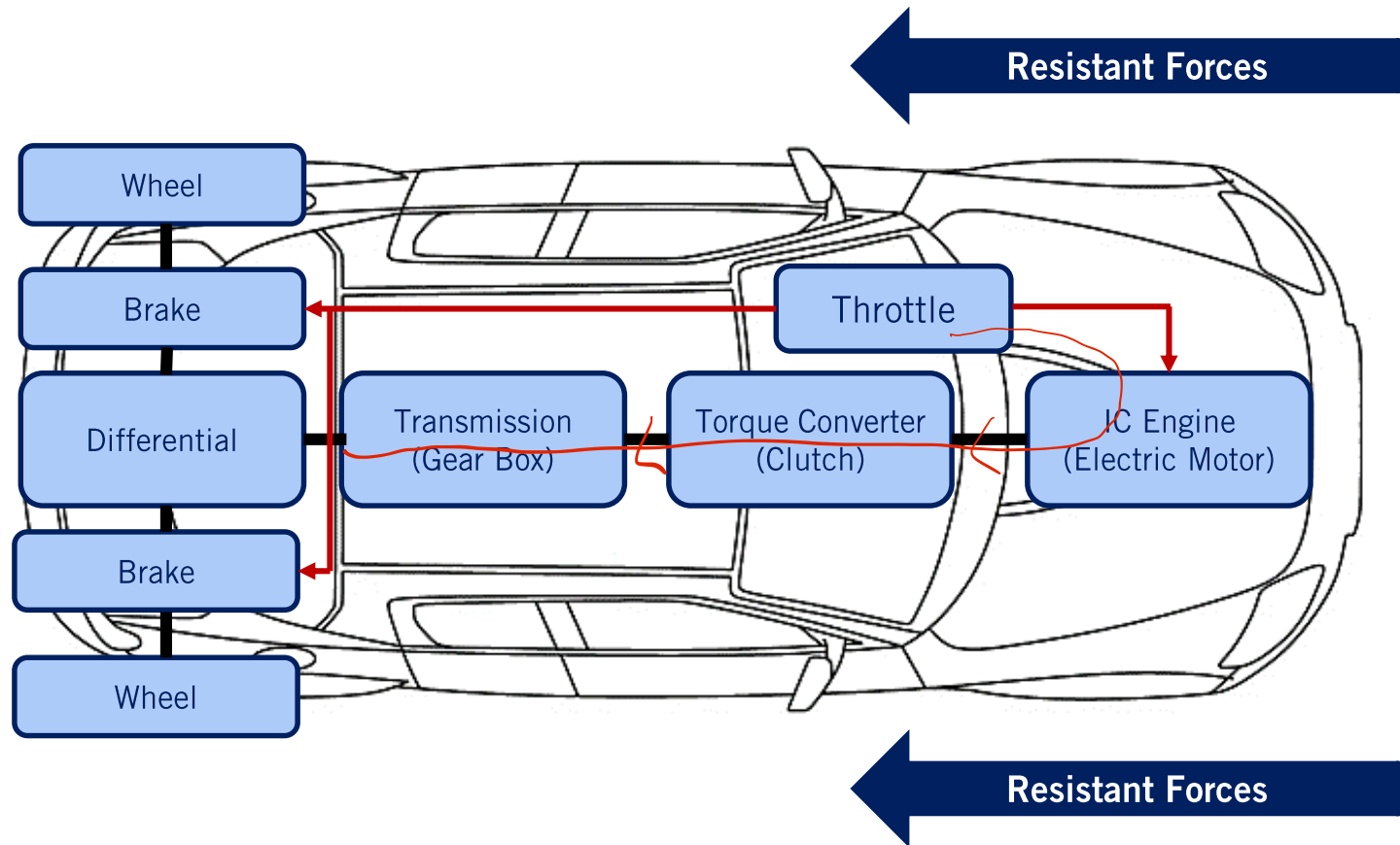


Actual Steering System

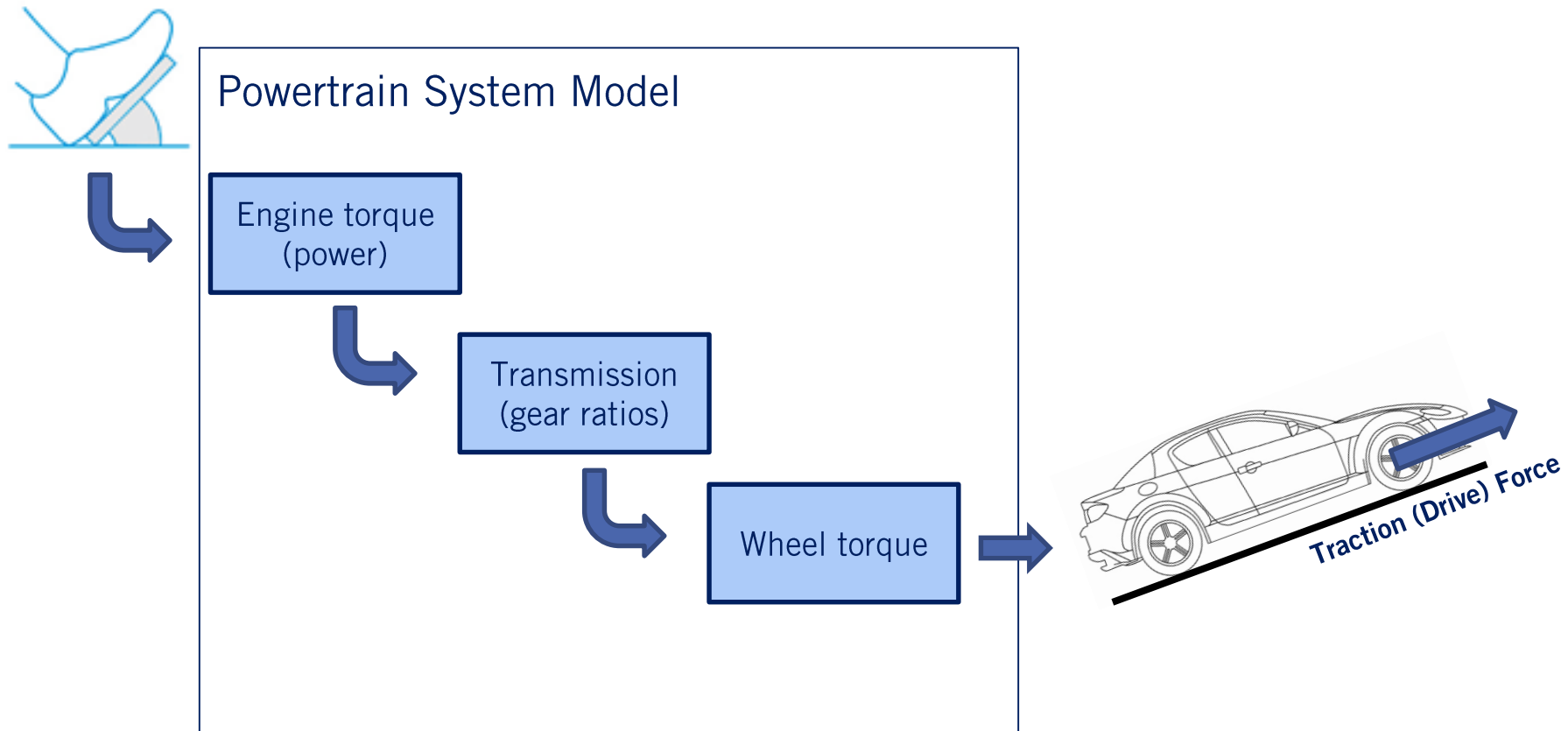


Powertrain System (Driveline)

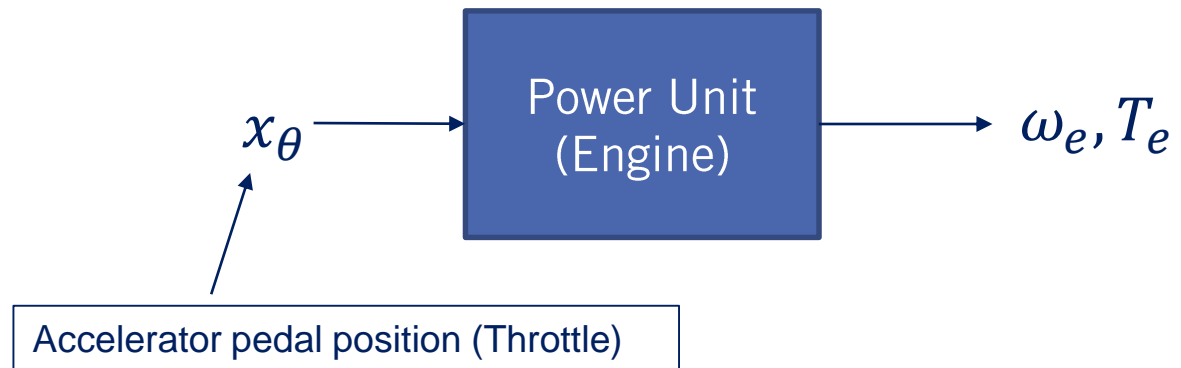
- Throttle and brake commands affect torque balance



Throttling (Accelerating)

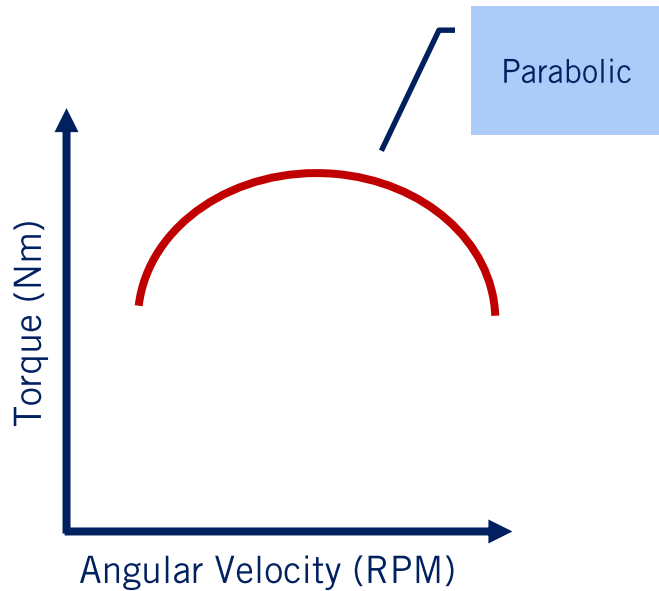


Accelerating Model

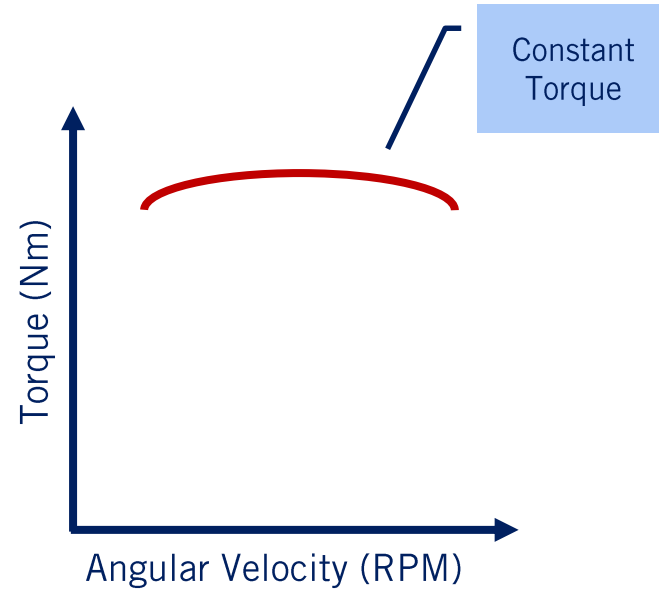


Characteristics Plots

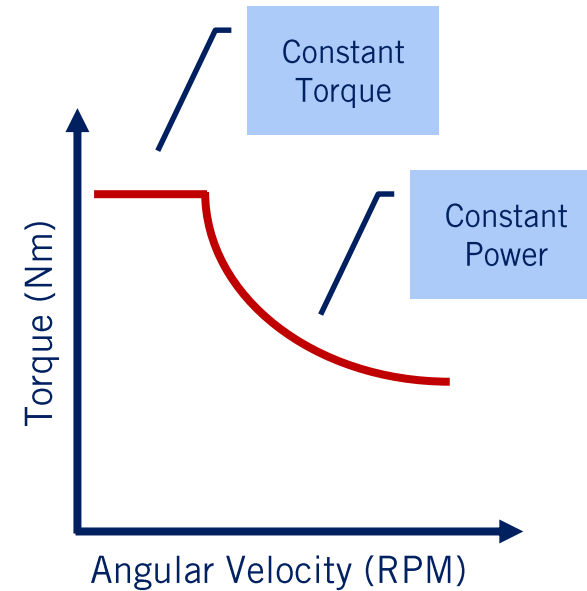
Gasoline Engines



Diesel Engines



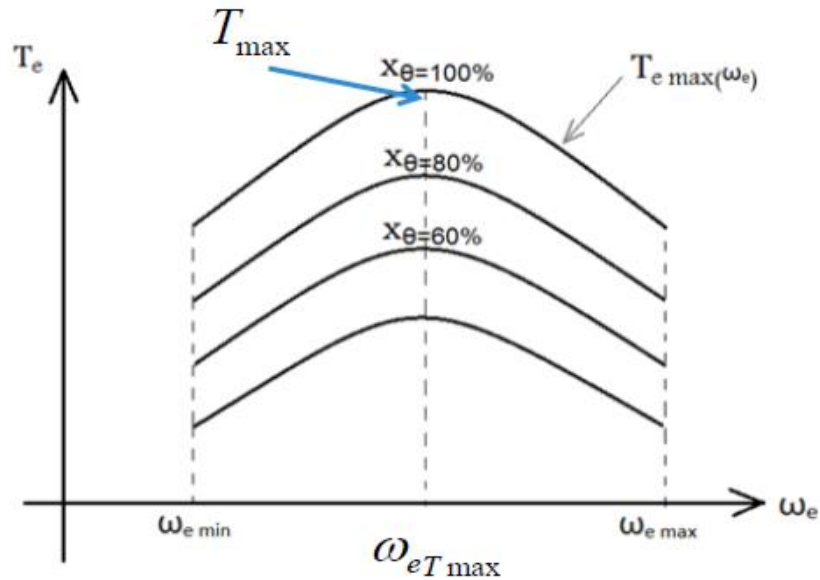
Electric Motors



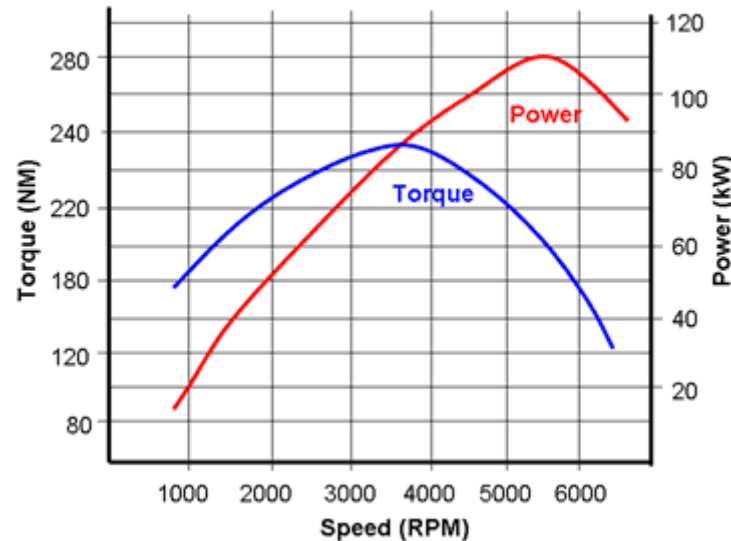
introduce
↳ hybrid
engine

2000-3000

Typical Torque Curves for Gasoline Engines



Engine Power and Torque Curves



$$T_{e \max}(\omega_e) = A_0 + A_1 \omega_e + A_2 \omega_e^2$$

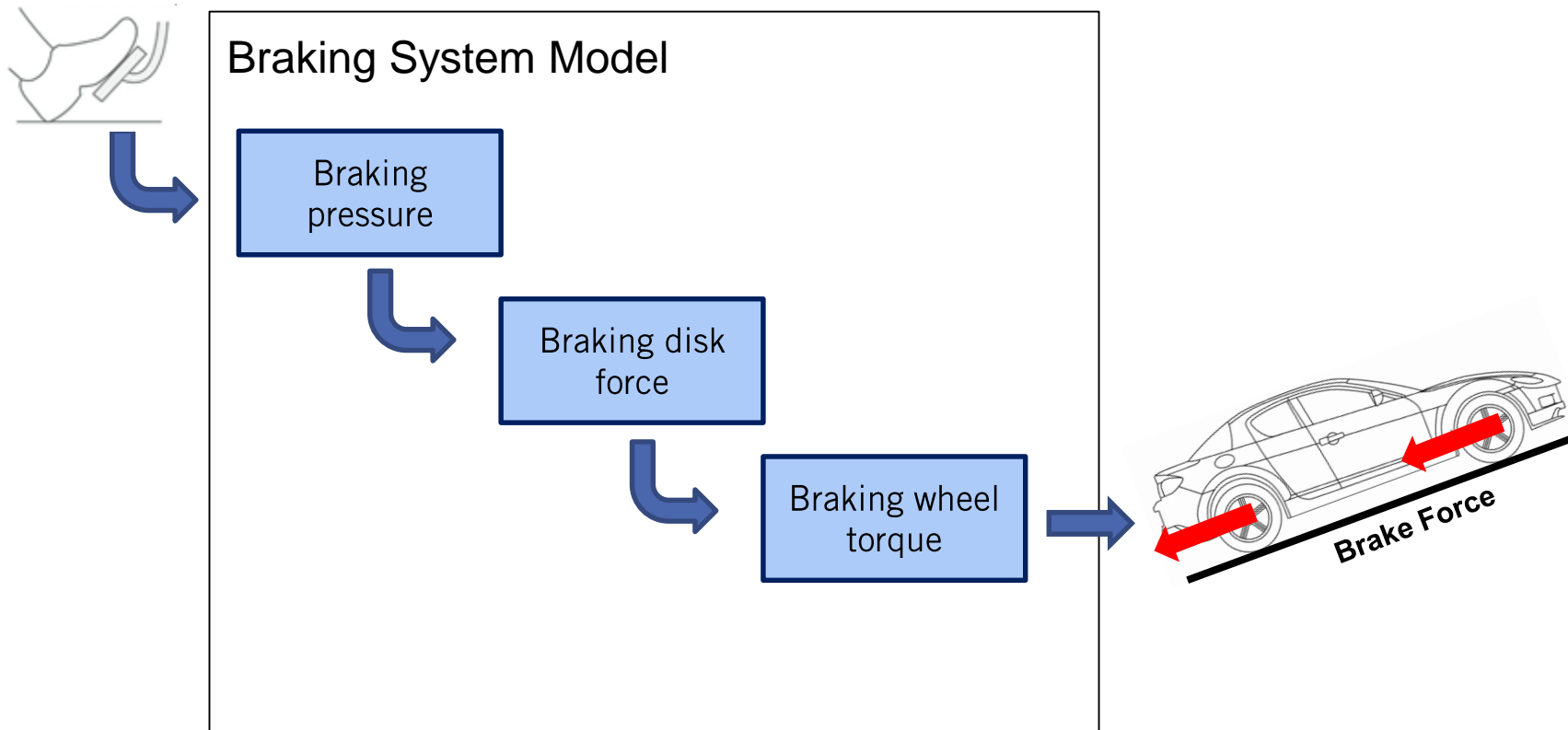
$$T_e(\omega_e, x_\theta) \approx x_\theta (A_0 + A_1 \omega_e + A_2 \omega_e^2)$$

↑
engine torque

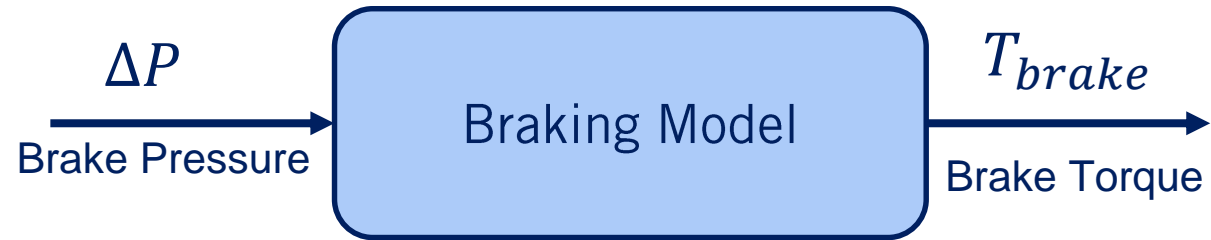
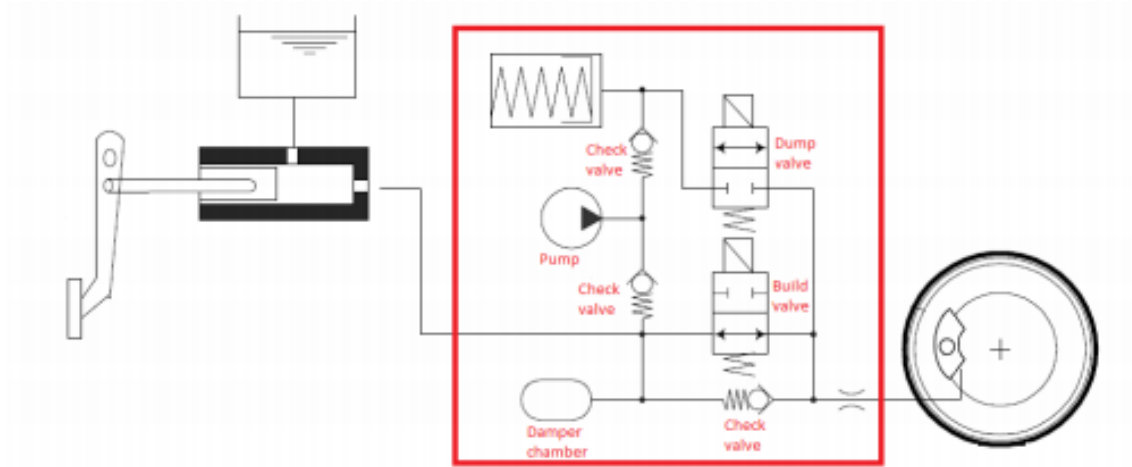
↑
Throttle position (percentage)

↑
engine angular speed

Braking (Decelerating)



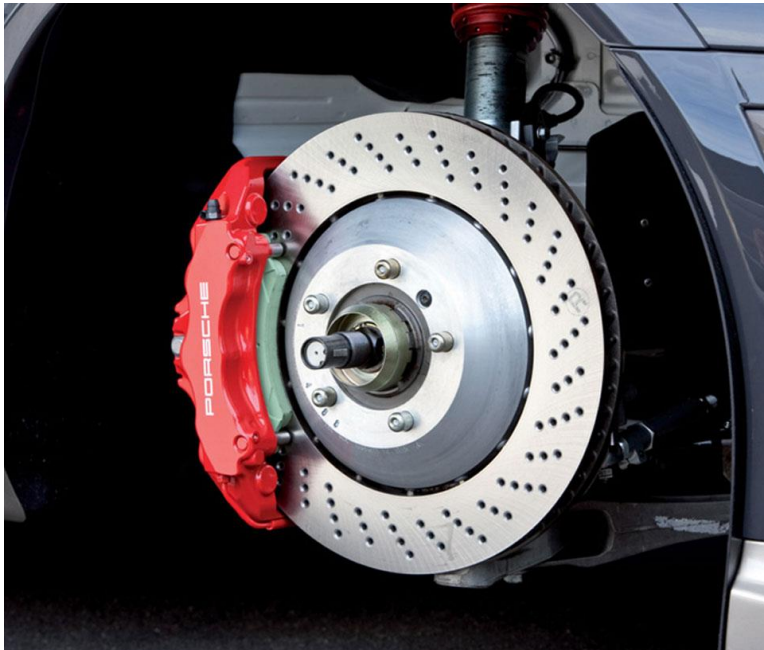
Braking Model



$$T_{brake} = k \Delta P$$

Braking System

- Basic functionality of braking includes:
 - Shorten stopping distance
 - Steerability during braking through ABS systems
 - Stability during braking to avoid overturning



Summary

What we have learned from this lesson:

- The workings of the vehicle actuation systems such as steering, power generation, and braking
- How to convert steering, throttle and brake inputs to wheel angles and torques

What is next?

- Tire modeling, connecting the car to the road