

Basic Dynamic Modeling in 2D

Course 1, Module 4, Lesson 3



UNIVERSITY OF TORONTO
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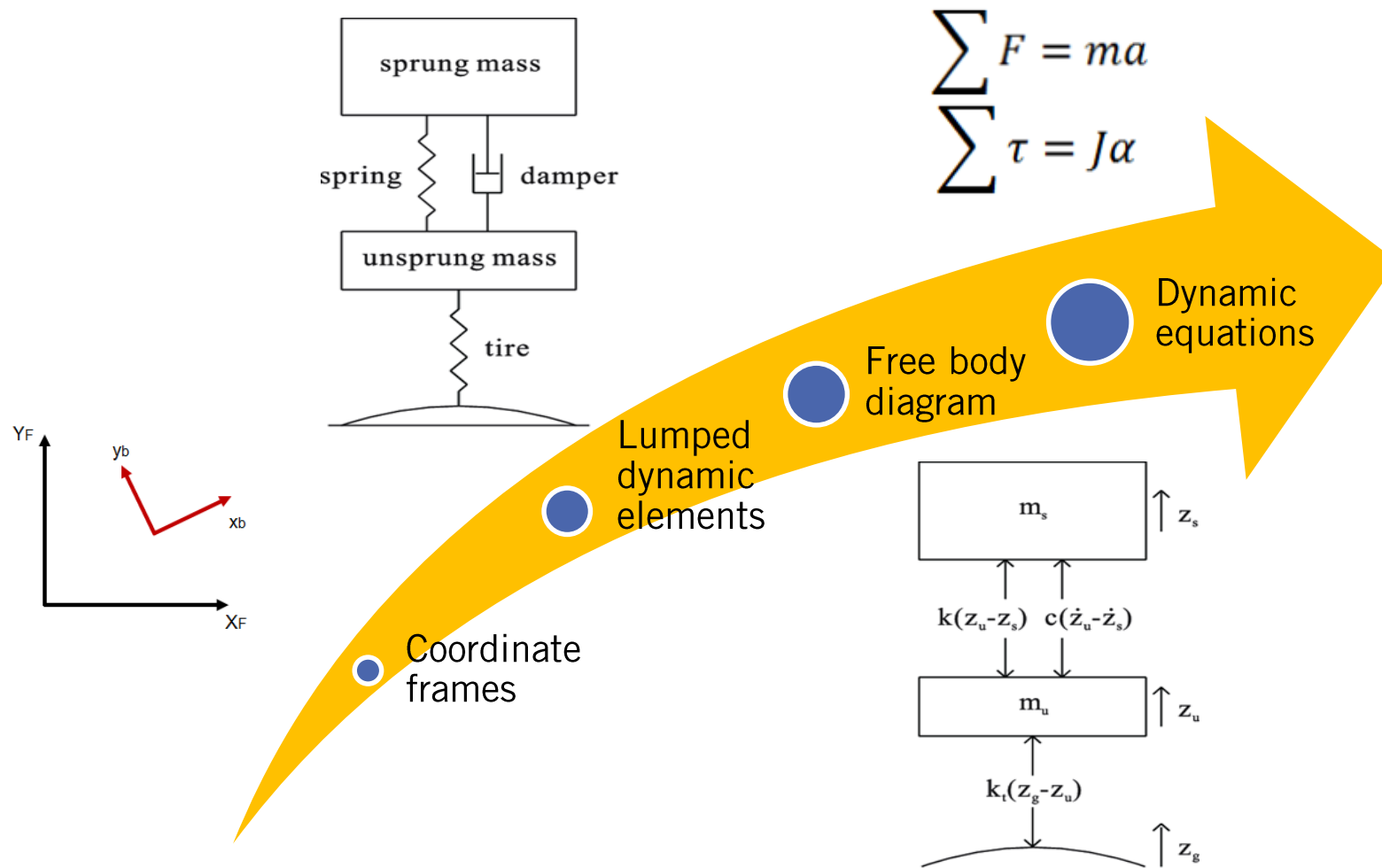
Dynamic Modeling

- Why Dynamic Modeling is Important?
 - At higher speed and slippery roads, vehicles do not satisfy no slip condition
 - Forces such as drag, road friction govern required throttle inputs



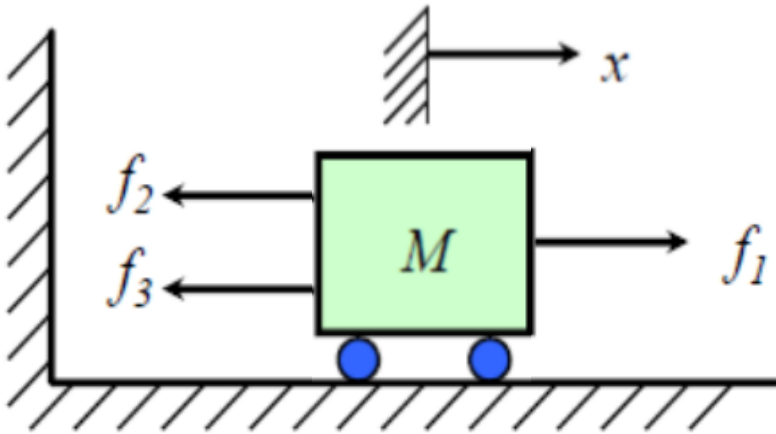
Dynamic Modeling

- Steps to build a typical dynamic model:



Dynamic Modeling - Translational System

- Deals with forces and torques
- Roughly, need to equate all forces
- Governed by Newton's second law



$$Ma = \sum F$$

$$M\ddot{x} = f_1 - f_2 - f_3$$

Example - Vehicle Shock Absorber (Suspension)

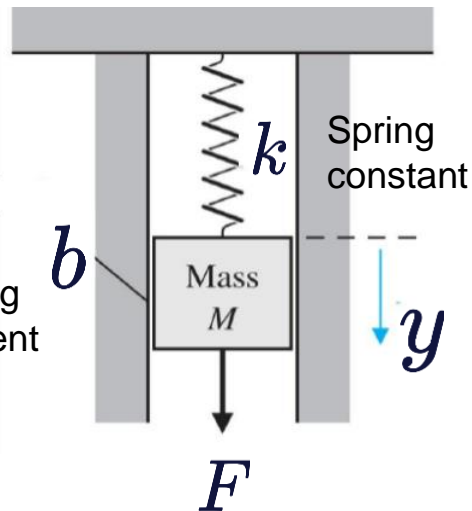


$$M\ddot{y} + b\dot{y} + ky = F$$

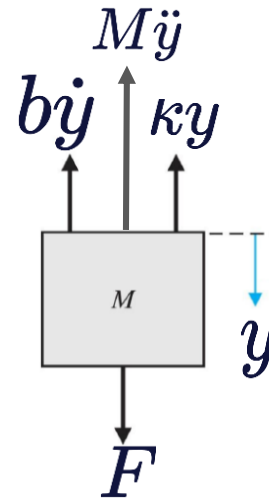
Coordinate system



Lumped dynamic elements



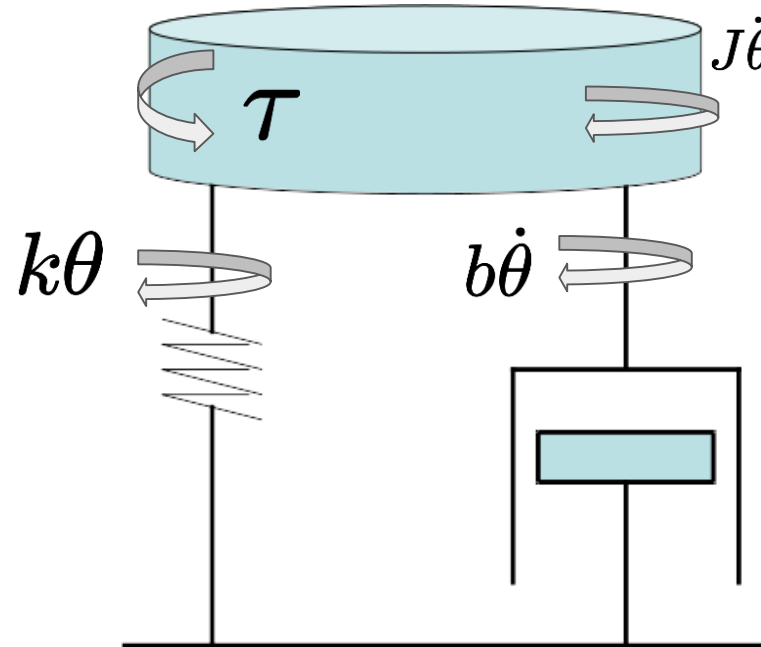
Free body diagram



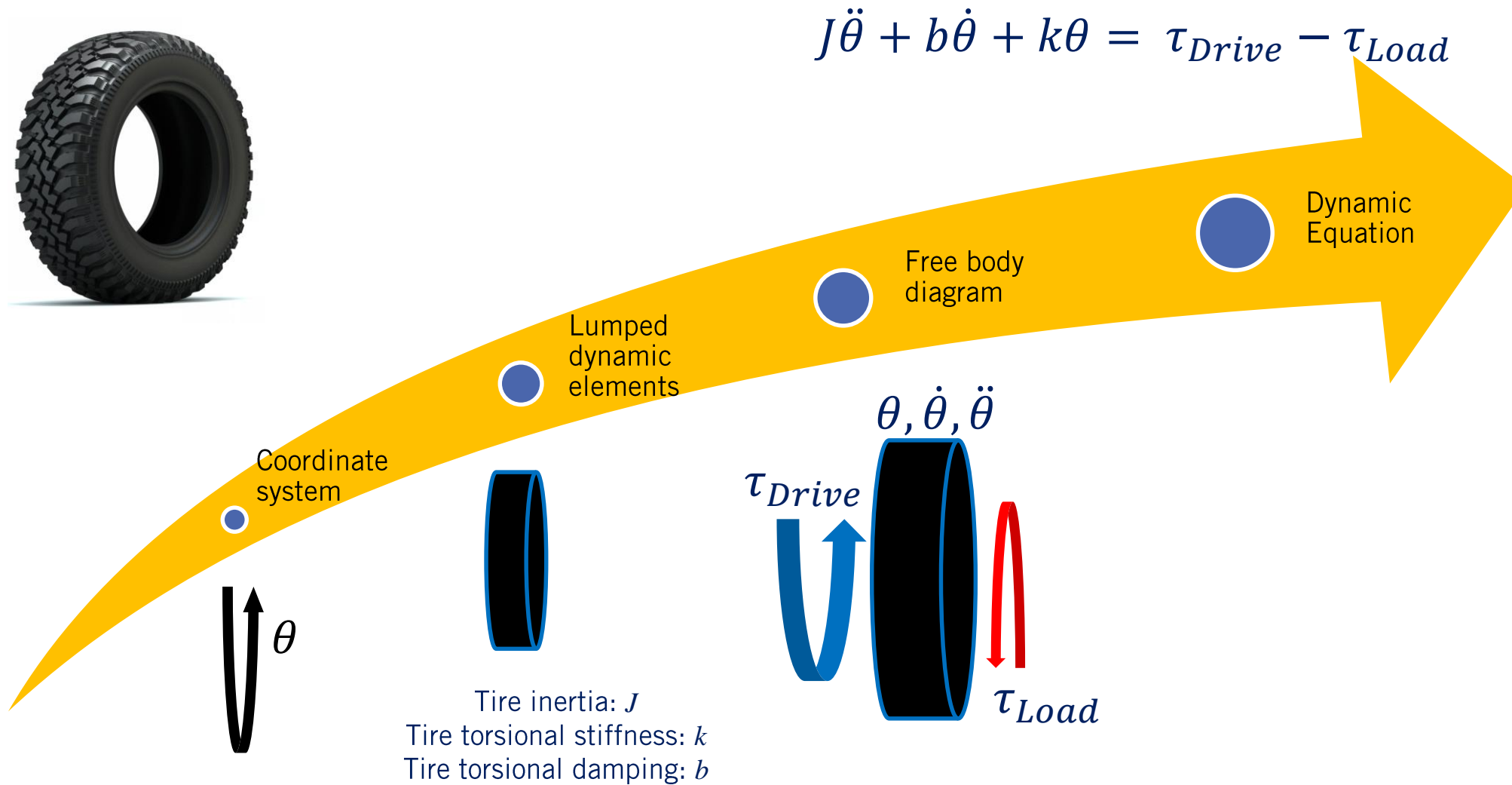
Dynamic Equation

Dynamic Modeling - Rotational Systems

- Inertia, J
- Torsional force, τ
- Forces resisting that torsional force
 - Spring force
 - Damping force
 - Inertia force



Example - Tire Model



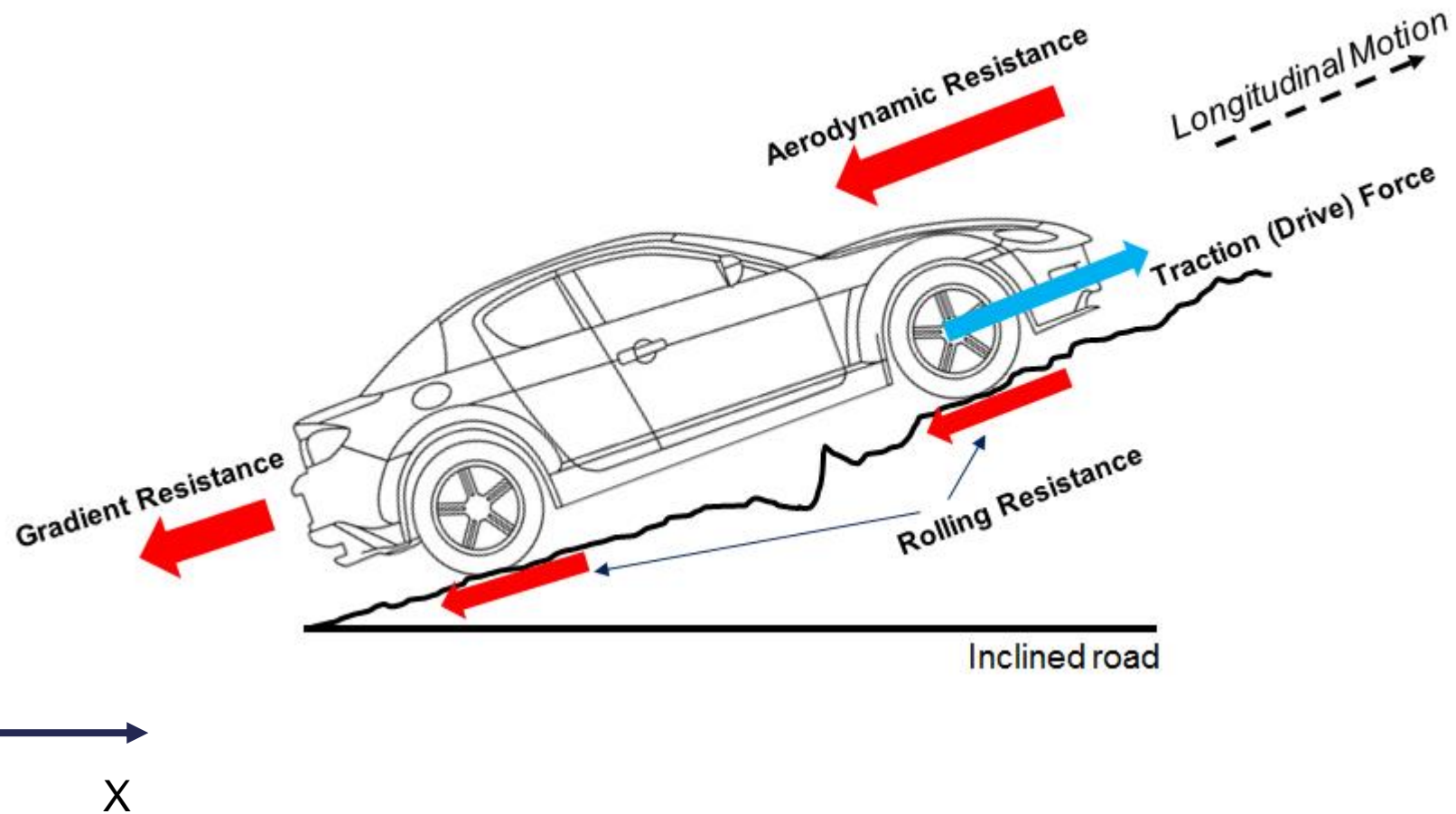
Full Vehicle Modeling

- All components, forces and moments in 3D
 - Pitch, roll, normal forces
 - Suspension, drivetrain, component models

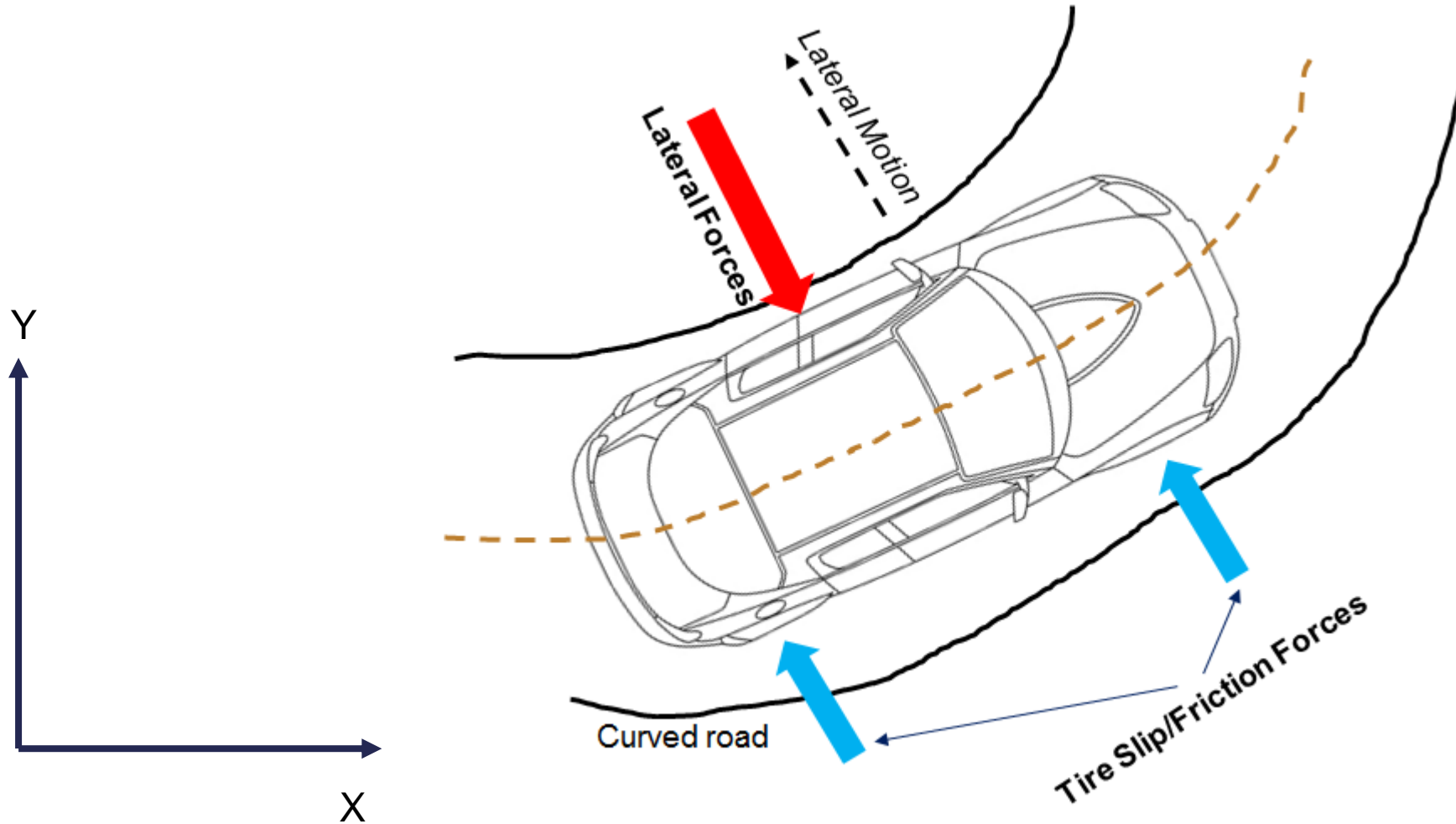


Project Chrono

2D Dynamics - Vehicle Longitudinal Motion



2D Dynamics - Vehicle Lateral Motion



Summary

- What we have learned from this lesson?
 - Basics of 2D dynamic and how to start modeling a dynamical system, along with some application in automotive.
- What is next?
 - We will take a look at the vehicle longitudinal dynamics and drivetrain system

