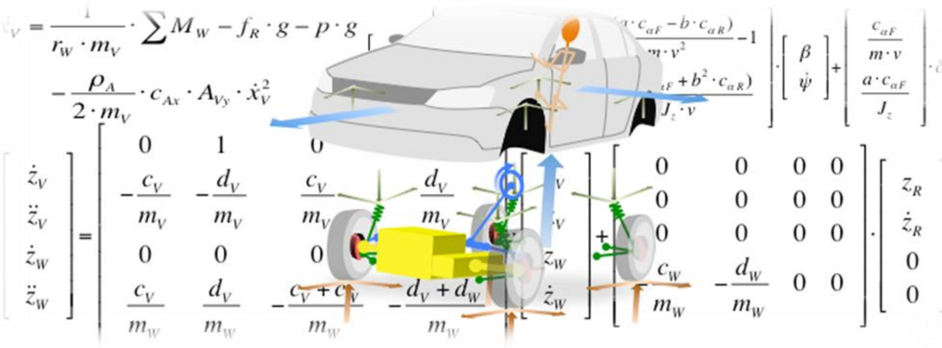
System Dynamics

An Introduction to Vehicle Dynamics and Controls



Summer Curriculum at Institut für Regelungstechnik
Technische Universität Braunschweig
Dr. Sven Beiker (Lecturer at IFR)

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Summary: Mechatronics have become more and more important for powertrain and chassis systems in automobiles. While the term already implies an integration of mechanics and electronics, the two fields are often being taught independently so that in practice the approach to designing such systems often lacks holistic consideration. Therefore this lecture series will revisit the fundamental laws of mechanics and apply these to the automobile to describe the dynamic process that electronic systems aim to control for improved safety, efficiency, performance, and comfort.

Objective: Students will be able to describe and analyze the basic dynamics of the whole vehicle and respective subsystems, formulate the underlying equations that are necessary to characterize the process for a control system, and determine algorithms to accomplish control objectives.

Prerequisites: Basic knowledge of mechanics (forces, acceleration, motion…), advanced knowledge of control theory (control loop, stability, model…), general understanding of an automobile (powertrain, chassis, body…)

System Dynamics – Lecture / Lab Schedule

Monday, Sep 9: *Introduction, Basic Mechanics*
10:30-12:00: Force, Acceleration, Motion
14:30-16:00: Force Plan, Equilibrium, Kinetics

Tuesday, Sep 10: *Mechanics and Application to the Automobile*
10:30-12:00: Free Body Diagram, Differential Equations
14:30-16:00: Forces Acting on the Automobile and Subsystems

Wednesday, Sep 11: *Longitudinal Dynamics*
10:30-12:00: Drive & Brake Forces, Modeling & Simplifications
14:30-16:00: Driving Performance, Resistance, Adhesion

Thursday, Sep 12: *Vertical Dynamics*
10:30-12:00: Tire Forces, Road Unevenness, Quarter Vehicle Model
14:30-16:00: Characteristic Values, Control Objectives

Friday, Sep 13: *Lateral Dynamics*
10:30-12:00: Tire Models, Bicycle Model, Stability
14:30-16:00: Characteristic Values, Control Objectives

Monday, Sep 16 – Thursday, Sep 19: *Lab Sessions to Further Extend on the Lectures*
10:30-12:00: Matlab Modeling of Dynamics with Respect to Automobile Applications

Friday, Sep 20: *Final Exam*
10:30-12:00: Testing basic mechanics, calculation models, control objectives