# 03MIQ – Automotive Control Systems

***Simulation (CarSim-Simulink ESP) laboratory exercises #3***

**Note**

For some help on each exercise refer to the instructions given in the *CarSim Handbook (CarSimHB.pdf)*.

**Lab 3.1: 15 November 2021 (exam matter)**

The aim of this and following exercises is to compare the closed loop behaviour of the vehicle yaw dynamic, controlled by the CarSim algorithm, with the activation/deactivation logic of the Kiencke Nielsen yaw dynamics control algorithm.

Select menu *Dataset* → *Simulink and LabVIEW Models* subset → *Yaw Control Diff., DLC w/ Low Mu* and generate a copy of this dataset.

- In Simulink, compare the vehicle side slip angle $\beta$ obtained from CarSim control and simulation with the maximum value $\beta_{max}$ (to be computed in real time using Simulink blocks) as defined in the Kiencke Nielsen book (chapter 10).
- The simulated angle $\beta$ respects the maximum value $\beta_{max}$?
- If yes:
  1. Which is the value of the gain "*control gain*" (default value 0.72) that brings the actual $\beta$ to reach for a time instant the $\beta_{max}$ limit? Is stability maintained? "Stability" in the sense that the car is able to follow the correct road trajectory (check it using the video or plots).
  2. Which is the minimum value of the gain "*control gain*" (default value 0.72) that makes the system unstable, in the sense that the car is not able to follow the correct road trajectory? And for a value close to stability limit (but still stable) how is the angle $\beta$ with respect to $\beta_{max}$?
- Using the $\beta_{max}$, build with Simulink blocks also the $\beta_{ref}$ signal, as defined in the Kiencke Nielsen book (chapter 10).

**Lab 3.2: 22 November 2021 (exam matter)**

Extend the previous exercise to the yaw rate variable $\dot{\psi}$ and compare it to the maximum value $\dot{\psi}_{max}$ (to be computed in real time using Simulink blocks) as defined in the Kiencke Nielsen book (chapter 10). Answer to *"limit" question 1* as in the previous exercise 3.1 substituting $\beta$ with $\dot{\psi}$. At the end build also the $\dot{\psi}_{ref}$ signal.

**Lab 3.3: 29 November 2021 (exam matter)**

The aim of this exercise is to implement the Kiencke Nielsen Yaw Dynamics control algorithm (ESP) exploiting the Simulink scheme developed for the previous exercises Lab 3.1 and Lab 3.2 and tune its design parameters exploiting the information achieved from the basic CarSim ESP implementation.