Title: Learning-based Autonomous Vehicles
(or Learning Control for Autonomous Vehicles)

Course Hours: 48
   Lecture Hours: 28
   Laboratory Hours: 20
Credit：3

Course description
Have you ever imagined that one day you would be in cars with no drivers? Actually, during the last several decades, considerable efforts have been made to design and develop highly autonomous vehicles which can drive with little or even no interventions from human drivers. In this course, a brief introduction about autonomous vehicles and fundamental self-driving technologies in terms of sensing, environmental perception, decision making, path planning and motion control will be given. Moreover, some state-of-the-art technologies of machine learning, reinforcement learning in particular, that can help to make a smart autonomous vehicle will also be introduced.

Course Content:
Lectures and Lecture Hours:
1. Introduction to autonomous vehicles (4 hrs)
   1.1 System architecture
   1.2 Environmental perception
   1.3 Decision making and planning
   1.4 Motion control
2. Overview of machine learning (4 hrs)
   2.1 Supervised learning
   2.2 Unsupervised learning
   2.3 Learning from demonstration
3. Reinforcement learning (10 hrs)
   3.1 Markov decision process
   3.2 Dynamic programming
   3.3 SARSA and Q-learning
   3.4 Function approximation for RL
   3.5 Novel RL technologies
4. Learning-based control for autonomous vehicles (6 hrs)
   4.1 Cruise control and car following
   4.2 Steering control and lane keeping
   4.3 Path-tracking control
   4.4 Learning from human drivers
5. Simulation platform for autonomous driving (4 hrs)
   5.1 Introduction to Airsim (or Carla)
   5.2 Scenarios construction
   5.3 Control system simulation

Laboratories and Laboratory Hours:

1. Basics of python (4 hrs)
2. Airsim (or Carla) (16 hrs)
   2.1 Scenarios construction
   2.2 Vehicle simulation
   2.3 Learning algorithm design and implementation

Text & Reference Book:

1. Özgüner, Ümit, Tankut Acarman, and Keith Alan Redmill. *Autonomous ground vehicles*. Artech House, 2011.
2. Sutton, Richard S., and Andrew G. Barto. *Reinforcement learning: An introduction*. MIT press, 1998.
3. Sutton, Richard S., and Andrew G. Barto. *Reinforcement learning: An introduction*. 2nd ed. 2017.