# ASSIGNMENT FOR CMPE-443 REAL-TIME SYSTEMS DESIGN (Fall-2023)

# Vehicle Motion Control (VMC) Real-Time System (RTS) Design

### General Task Formulation

### Design an RTS for manual control of a vehicle using STVM (single track (linear) vehicle model, see [1], Section 3.1.1, p. 66; [2], Section 7.5, p. 443)

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### and NLVM (non-linear vehicle model, see [1], Section 3.1.2, p. 69) models

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### of a vehicle motion as a plant simulator controlled by inputs received from a user. A user shall see on the screen road in front of him. Simulator shall solve respective equations numerically using Euler and Runge-Kutta methods. Parameters of a vehicle shall be modifiable with default values as defined in [1], Table 3-2 for STVM, and Table 3-4 for NLVM. These equations are to be solved numerically as in Labs 1-2, providing dependency of the state of the system on the time, initial conditions and control actions. A user shall be able controlling vehicle motion on a road with dynamically changing scenes rendered on the monitor.

### What must be done

The system **must** have the following parts:

* vehicle simulator;
* vehicle visualization system;
* user interface.

User interface must support an opportunity to arrange our RTS (**introduce** vehicle **characteristics – length, masse, initial position and velocity, time step for modeling, time step for controlling**; **start/stop**, etc.)

Vehicle visualization system is to output:

* vehicle image, most appropriate to its current state;
* table of the last 10 values of position and velocity;
* current parameters of the system
* assume that motion of the vehicle is not limited by the window

Vehicle simulator is to determine what must be the vehicle state at the next moment of visualization depending on its previous state and control action. Frequency of visualization must be approximately **20 times/sec (each 0.05 sec screen must be refreshed**).

Mentioned above parts may be implemented by separate developers and then integrated.

### Implementation requirements

1. Assignment may be performed by teams of **3-4** people.
2. Each team submits **a report** with the names of the participants specified. **Copies are not allowed and will be graded by zero if any.**
3. In the Introduction to the report, **responsibilities of each team member** **must be explicitly shown** (what parts out of the mentioned in “What must be done” or what combination of them was realized by each person).
4. **Printed out** report must include: Title (department, course, assignment name, names and ids of participants, semester, year), Introduction (what for the work is to be done), Task definition (what must be done, mathematical model, requirements to implementation), Conceptual design (idea of approach, show parts of the task, their links and interaction), Description of the program implementation (procedures, interfaces, their interactions), Description of testing (separate testing, integration process, integrated testing, what examples have you tried, results of testing, screenshots), Instruction to a user (what, where and how should be installed to make your program working), Conclusion (what was really achieved in comparison with supposed), References to cited sources if any, Appendix (**source codes which shall be referred to from the main text).**
5. Reports submission due date: **Monday, December 25, 2025, 16.00. Hand printed report to the Lab Coordinator** [LEILA MOHAMMADIAN VAIGHAN](https://cmpe.emu.edu.tr/tr/hakkimizda/personel/personel-detayi?sid=266&n=leila-mohammadian-vaighan)**.** Z***ip file* with all related to the Term project materials (report, sources, executables, libraries, etc. allowing installation of the program from it, and its further invocation, user’s guide, etc.) shall be uploaded in Teams assignment (TBD). LATE SUBMISSION WILL BE fined: 10% per day of delay.**
6. You are to be ready to demonstrate your program and give necessary explanations on the work done at the time and place which are to be announced later**.**
7. **BONUS: 10% out of the Term Project points can be additionally earned if additionally to manual control implementing an automatic controller as described in [1], Section 3.1.3, p. 79.**

### References

1. Mark Albert Selby, Intelligent Vehicle Motion Control, PhD Thesis, Univ. of Leeds, Department of Mechanical Eng., 2003, 224 p. [link to Intelligent Vehicle Motion Control](https://staff.emu.edu.tr/alexanderchefranov/Documents/CMSE443/CMSE443%20Fall%202023/Selby2003%20Intelligint%20vehicle%20motion%20control.pdf)
2. John C. Dixon, Tires, suspension, and handling, 2nd Edition, SAE International, Warrendale, USA, 1996, 621 p., SAE ISBN 1-56091-831-4 [link to Tires](https://staff.emu.edu.tr/alexanderchefranov/Documents/CMSE443/CMSE443%20Fall%202023/pdfcoffee.com_tires-suspension-and-handling-1-56091-831-4-pdf-free.pdf)