Course description TME047 – Chalmers Formula Student

Content

This is a course where you will design, build and test an electric Formula Student race car together with other students in a team. This year the car should have the capability to be driven both manually and autonomously. The team is divided into subgroups that are responsible for different technical areas of the car or project functions. Each participant in the course will be given their own areas of responsibility to fulfil to complete the car and the project. The finished vehicle must fulfil the current competition rules for Formula Student Germany (FSG) and competition specific rules.

Aim

The aim of this course is that you should gain hands-on knowledge and experience from a large engineering project. The course concerns a total car concept where the entire process from conception and design to implementation and operation is covered. In addition to the technical aspects, system-based thinking, communication, and teamwork are important.

Learning outcomes

Learning outcomes (after completion of this course, the student should be able to):

- Apply functional and solution models in the concept phase of an engineering project to analyse and create concepts for vehicle parts and systems.
- Apply Computer Aided Engineering (CAD, data replay, and simulation tools) to design and analyse vehicle parts and systems.
- Produce drawings or other basis for manufacturing or development that can be understood by a third party.
- Lead structured meetings. The requirements for a structured meeting are that there is an objective and agenda for the meeting and that notes are taken where conclusions and actions from the meeting are recorded.
- Create a project planning that includes tasks and deliverables with due dates and responsibles.
- Derive engineering requirements for a technical system or part using a goal hierarchy method.
- Show understanding for how an individual part or subsystem contributes to the system as a whole, and that the added value to the system (and its cost efficiency) can vary greatly between different part or subsystem options.
- Manufacture, develop, or assemble parts within one of the areas: metals, plastics (e.g. carbon fibre reinforced plastics), electronics, or software.
- Perform physical tests of a vehicle or vehicle subsystem and evaluate their performance against design targets.
- Analyse and explain discrepancies in theoretical and measured performance for a component or system.
- Communicate work status and issues to team members throughout the project
- The student should demonstrate understanding for the concept of diminishing returns

Literature

- The CFS Handbook by Magnus Urquhart. Available at Store in the Student Union Building.
- Presentation slides from lectures

- Video lectures and tutorials on automated software engineering processes
- Descriptions of tasks and methods for each project phase will be made available once the course has started.
- Current Formula Student Germany Rules and competition specific rules.

Course personnel

	Name	**Telephone**	**Email**
Examiner and main supervisor:	Björn Pålsson	031 – 772 14 91	bjorn.palsson@chalmers.se
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Software systems advisor:	Ola Benderius	031 – 772 20 86	ola.benderius@chalmers.se

Examination

The examination is based on work performed in the project, written reports, oral presentations and peer reviews. To be approved in the course active participation in the project, work of sufficient quality and satisfactory presentation of results are required. Compulsory activities only concern relevant safety instructions for lab activities. TME047 consists of two parts of 3 and 12 credits where the first three credits cover study periods 1 and 2 while the 12 credits cover study periods 3 and 4. The final grade will not be given until study period 1 of the following year. For the first part the grading is Passed/Not passed and for the second part and the final grade the scale is: Five, Four, Three and Not passed.

In order to pass part one you need to

- Participate actively in the project and demonstrate work of sufficient quality and quantity
- Contribute to the pre-study report for your subgroup
- Submit the first peer review
- Attend mandatory activities for this part
- Make an individual presentation of your design work including the submission of presentation slides

If you don’t pass part one you are not allowed to continue with part two.

In order to pass part two you need to

- Participate actively in the project and demonstrate work of sufficient quality and quantity
- Submit an individual design report and participate in an individual design report review
- Make an individual presentation of your manufacturing work including the submission of presentation slides
- Submit an individual final report
- Submit the second and third peer review

The grading for part two and the final grade of the course (which covers the whole course) will be decided from the following constituents

Project work 60% whereof

- Understanding/proficiency of the fundamentals in your discipline of work 20%
- Project contribution 20%
- Team interaction, Responsibility & Commitment 20%

Final report 40% whereof

- Content 30%
- Report writing technicalities 10%

Hence, your final grade will then be based on 50% in technical examination, 40% in project and teamwork and 10% in formal report writing.

For examination there are two categories of assessment criteria depending on whether you are working in a technical subgroup with mechanical, electrical or software systems or if you work with the industrial economics aspects of the project in the business and management group. There is partial overlap between the categories, but they differ in terms of the assessed subject matter.

In the grading process for engineering subgroups it will be assessed to what degree you have

- Demonstrated the ability to make solution independent definitions of vehicle functions.
- Considered different concept and design choices and have performed a systematic evaluation of these using engineering requirements.
- Demonstrated the ability to formulate appropriate engineering requirements for a part or subsystem that are aligned with the overall engineering requirements for the vehicle and the Formula Student competition format and rules.
- Demonstrated design work in CAD, schematics or software architectures and deployment that are appropriate for the overall vehicle concept and the Formula Student competition format and rules.
- The extent to which you have considered DFMA (Design for manufacturing and assembly) or DevOps and cost effectiveness in your design work. Also “Design for scrutineering”, i.e. to the extent that you have considered that the car should be easy to inspect at the competitions will be considered.
- Produced drawings or other basis for manufacturing and development that can be understood by a third party
- Manufactured quality parts within one of the manufacturing areas metals, plastics or electronics, or developed quality software components.
- Performed conclusive physical tests to evaluate the performance of parts or software with respect to design targets.
- Contrasted simulation, data replay, or other theoretically derived performance of a part or subsystem to measured performance and analyzed the reasons for discrepancies.
- Contributed to structured meetings. The requirements for a structured meeting are that there is an objective and agenda for the meeting and that notes are taken where conclusions and actions from the meeting are recorded.

- Continuously contributed to a project planning that include tasks and deliverables with due dates and responsibles.
- Communicate work status and issues to team members throughout the project.
- Positively contributed to the project in terms of material productivity and work organization and coordination in the project.
- Submitted clear and readable reports.

In the grading process for the business and management subgroup it will be assessed to what degree you have

- Thoroughly benchmarked and evaluated different concepts for the business plan or cost models for the cost and manufacturing event.
- Demonstrated the ability to produce quality content for a) the BPP (presentation and background materials) or cost and manufacturing events (cost explanation file) that are aligned with and the Formula Student competition format and rules.
- Produced quality information and marketing material for the project.
- Formulated, coordinated, and documented sponsorship agreements for the team.
- Contributed to structured meetings. The requirements for a structured meeting are that there is an objective and agenda for the meeting and that notes are taken where conclusions and actions from the meeting are recorded.
- Continuously contributed to a project planning that include tasks and deliverables with due dates and responsibles.
- Communicate work status and issues to team members throughout the project.
- Positively contributed to the project in terms of material productivity and work organization and coordination in the project.
- Submitted clear and readable reports.

Grades are set according to the following process; The examiner will, based on the final report, individual presentations throughout the project and project work set an individual grade. In this process input from supervisors and peer reviews will be considered.

Mandatory activities

The mandatory activities in the course and the course participants concerned for each activity are listed below.

Activity	**Applies to**	**Time**
Safety introduction	All course participants	Sp1
Electrical safety lecture	All course participants that will work with HV systems	Sp2
Chalmers course on allergenic chemical compounds	Everyone that will work with epoxy or cyanoacrylate glues	2021-09-29 13.00-15.00 or 2021-11-02 09.00-11.00
CFS course on allergenic chemical compounds	Everyone that will work with epoxy or cyanoacrylate glues	Sp2

Safety courses in prototype workshop	Everyone that will be using the prototype workshop for metals or wood manufacturing	Sp2
Safety course for electrical lab activities	Everyone that will be using the CASE lab or CFS's electronics corner for electronics work	Sp2
Risk assessment lecture for lab activities	All course participants	Sp3
Vehicle testing safety training	All course participants	Sp3

Summary of changes since the course was given last

The separate hand-ins for a) an engineering specification and b) a drawing or other basis for manufacturing have been removed. Individual reviews have been added after design report submission in sp3 and in sp4. The project has been expanded in that the car should be equipped with an autonomous system. The assessment criteria in the examination process have been elaborated.

Organisation

The general organisation of the Chalmers Formula Student project consist of:

- Lectures
- Weekly team meetings
- Weekly subgroup meetings
- Project phase dependant team organisation with subgroups and roles with different areas of responsibility
- Written project reports (Pre-Study, Design, and Final)
- Presentations during pre-study from each subgroup
- Three individual work reviews in total during design and manufacturing

In Figure 1 the general timeline for the CFS project is shown. The project consists of 7 parts: Application, Concept, Design, Manufacturing, Testing, Competitions and Handover. The project phases Concept, Design, Manufacturing and Testing/Competition follows the CDIO (Conceive, Design, Implement and Operate) educational framework. The idea behind CDIO is to enhance learning by allowing students to get direct feedback on their own concept and design work through implementation and operation of their creations. It is important to recognise that the Formula Student competitions assess the final product during operation, and without sufficient testing of the vehicle before competitions the learning and feedback on the design systems will be smaller and the competition performance will most likely be lesser.

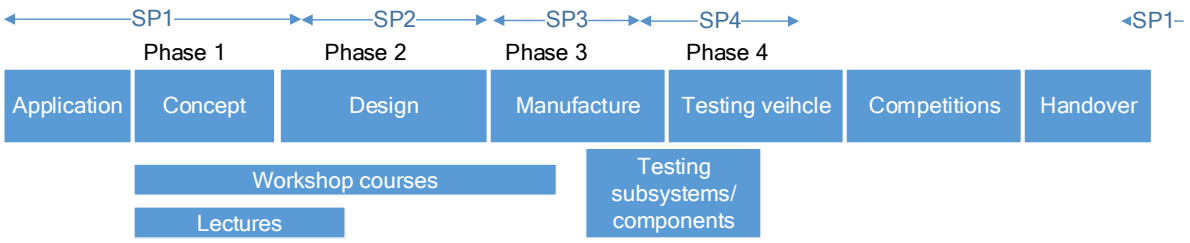

Figure 1. The general time line for the Chalmers Formula Student project.

Time plan

Date	
Application, Study period 1, Study weeks 1 and 2	
2021-08-29 to 2021-09-08	Application period for CFS22. The application procedure is described on the CFS homepage www.chalmersformulastudent.se
2021-09-08 at 23:59	The application deadline
2021-09-13 to 2021-09-17	Interviews. After reviewing the applications the examiner will call the interesting candidates for interviews
2021-09-18	Announcement of team members for CFS22. The team members are selected by the examiner together with student managers based on applications and interviews. The selected students will thereafter be registered on the course Chalmers Formula Student (TME047).
Concept phase, Study period 1, Study weeks 4 to 7 The outcome of the concept phase should be chosen solutions for each subsystem. The technical detail of concept choices can vary, but should be detailed enough such that design work can start. A concept solution could for example specify chassis technology, damper type and damper mounting configuration, battery chemistry/cell type and assembly method, battery location in the vehicle and removal procedure etc. In the concept phase all team members should also gain knowledge about the Formula Student competitions and rules.	
2021-09-21 at 12:15	Start-up team meeting
2021-09-21 to 2021-10-19	The concept phase will include • Introduction to CFS and the CFS21 vehicle • A lecture on the Formula Student challenge • A lecture on electric drive systems for vehicles • Rules quizzes • Introduction to CAD and other software tools • Team building activities
2021-10-23	**Deadline for the concept phase subgroup report**. A template and scope for the report will be provided.
Design phase, From Study period 1 Study week 8 to Study period 2 Study week 8 The objective of the design phase is to produce a vehicle design in 3D-CAD that is compliant with the FSAE rules and can be manufactured within the resources and time frames available to CFS. At the end of the design phase there should be a manufacturing basis available for all parts of the vehicle.	
	The design phase will include

	• Lecture on electric drive systems • Compulsory Electric Safety course • Design reviews • An individual presentation of your design work
2021-12-20	Design lock down
Mid-February 2022	**Deadline for the individual design reports**. A template and scope for the report will be provided The individual design report will not be graded at this stage, but individual feedback will be given on the report.
Manufacturing phase, Study week 1 of Study period 3 until end of April In the manufacturing phase the vehicle is produced according to the manufacturing basis of the design phase. The manufacturing phase also includes testing and verification of subsystems.	
2022-04-29	Rolling car deadline
Testing phase, May and onwards In the testing phase the functionality and reliability of the vehicle is verified and the performance is enhanced through tuning and improvement of parts and systems.	
2022-05-14	Public Launch of the running CFS22
Competitions, The course provides the funding for participation in one competition. The student team can participate in more competitions given that sufficient sponsorship is found.	
Mid-July 2022	FSN? FS-East?
Mid-August 2022	FSG
Summing up and Handover	
Wednesday in study week 1 of study period 1 2022.	**Deadline for the individual final report**. This is the version of the report that will be graded. It is allowed to make changes to the design part of the report before the final report is submitted. Requirements and a template for the final report will be provided. The final reporting will include a set of hand over files to the next team.