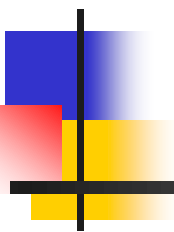


# MECA0063: VEHICLE ARCHITECTURE AND COMPONENTS



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Prof. Pierre DUYSINX  
Automotive Engineering  
University of Liège  
Academic Year 2021-2022

# Course targets





# Course Target

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- Overall layout of the vehicle and its major components and sub-systems in a system approach
- Direct connection between performance criteria / dynamics behavior and the choice of components and sub systems
- Presentation and discussion of the most usual technological solutions available in present and past vehicles



# Course target

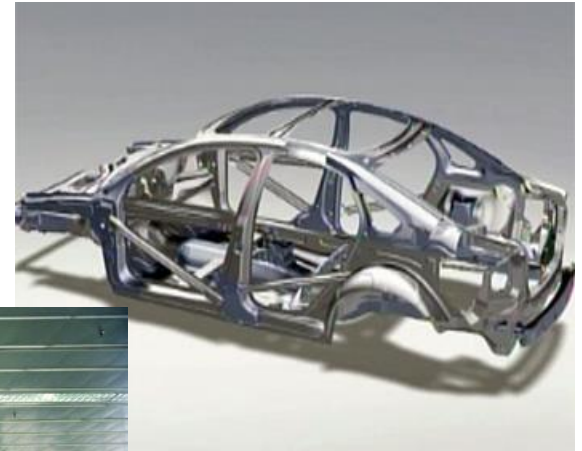
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- Fundamentals: reinforcement of
  - Machine design and construction, Technology, Dynamics of Mechanical Systems, Kinematics and Dynamics of Mechanisms
  - Numerical methods: Finite Element Method, Multi Body System Dynamics, Structural optimization
- Introduction to engineering Design:
  - Computer Aided Engineering (CAE)
  - Design using Simulation and Optimization
  - Simultaneous engineering

# Main topics



Powertrain and Transmission systems



Body and structures



Active and Passive Safety



Design methodology and numerical design tools



Rolling gear and suspension



# Course Layout

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VEHICLE ARCHITECTURE (10/02)

BODY AND FRAME DESIGN (17/02)

- Load cases and design scenarios
- Construction technologies of body
- Body preliminary design methodology using SSS approach
- Simulation using FEM and structural optimization

LIGHTWEIGHT DESIGN (seminar by M. Belhabib, 10/03)

INTRODUCTION TO TOPOLOGY OPTIMIZATION (17/02)



# Course Layout

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## POWERTRAIN

- Transmission I (24/02)
  - Clutches
  - MT gearboxes
- Transmission II (03/03)
  - AT gearboxes (AT, CVT)
  - Differentials
  - Axles
- Visit of JTEKT Torsen-Europe@ Streppy Braquegnies, N. Poulet (08/04)



# Course Layout

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## CHASSIS, SUSPENSION AND ROLLING GEAR

- Design of suspension Mechanisms (17/03)
  - Geometry of wheels
  - Design of suspension mechanisms: characteristics
- Axle technologies (24/03)
- Anti dive & anti squat systems (31/03)
- Suspension elements (springs, shock absorbers, etc.) (21/04)

## STEERING MECHANISMS (28/04)





# Course Layout

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## BRAKING SYSTEM (05/05)

- Reminder: Braking Performance
  - Ideal braking distribution
  - Braking in non ideal conditions
- Braking system
  - Brake technology (drum, disks)
  - Braking system
- Anti Lock Braking systems (ABS) (12/05)



# Course Layout

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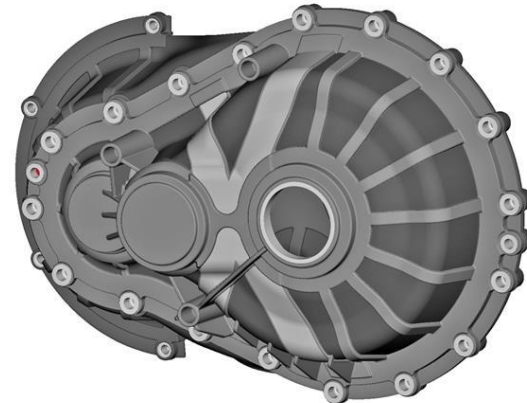
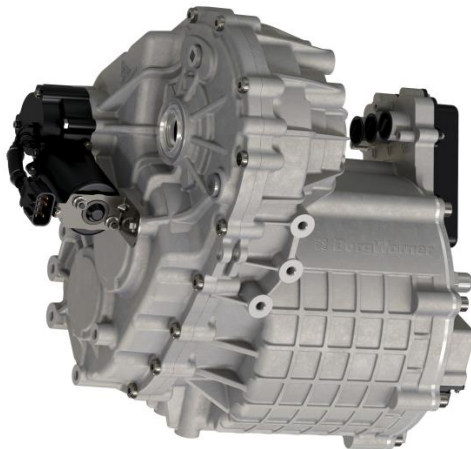
- ACTIVE AND PASSIVE SAFETY
  - Introduction to active and passive safety (07/12)
  - ABS
  - ESP
  
  - ADAS (seminar by F. Christen, 19/05)
  - Autonomous Driving (seminar by S. Christiaens 19/05)



# Course Layout

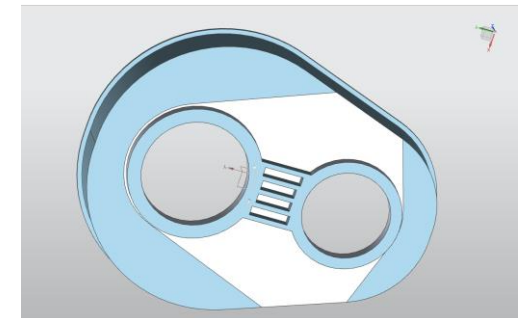
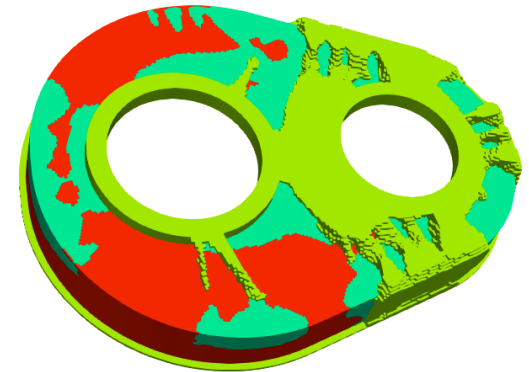
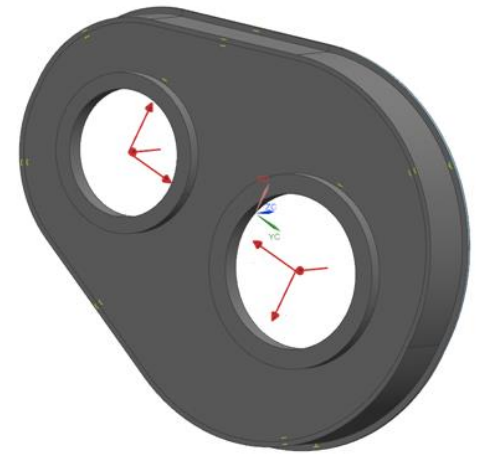
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- Design project : **Lightweight design of a gear box rear cover for electric vehicles**
  - Revisit the design of gear box casing for EVs
  - Generation of new concepts using topology optimization and multi material designs



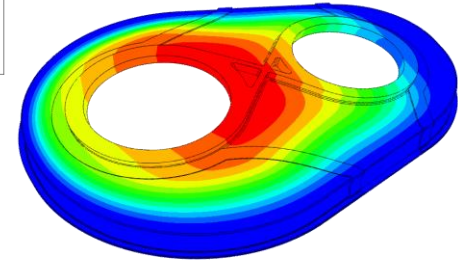
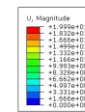
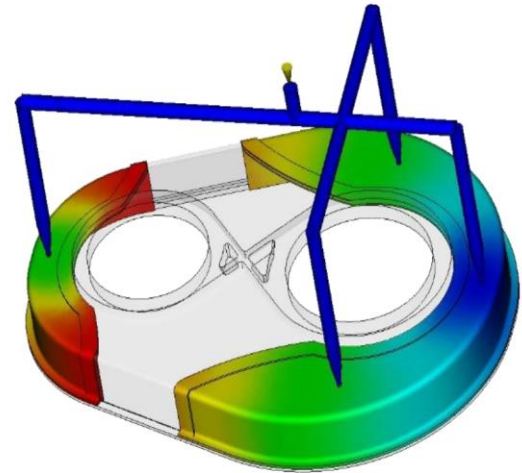
# Design project

- Lightweight design
  - -25% mass / -25% CO<sub>2</sub>
- Revisit the concept
  - New concepts using topology optimization
  - Multi material design
  - CAD design
  - New fabrication process
  - Verification of performance using FE simulation: static loading (displacements, stresses) and natural vibrations



# Design project

- Phase 1: New concept using topology optimization
- Phase 2: Component design
  - New CAD model
  - Multimaterial solutions
  - Function integration
- Phase 3: FEM validation
- Phase 4: LCA assessment



ODB: Eigen.odb Abaqus/Standard 3DVIEWER F0016 Wed Apr 14 16:26:30 Romance Daylight Time 2021

Step: Step-2  
Mode: 1, Value = 9.26727E+05 Freq = 144.71 (cycles/time)  
Primary Var: U, Magnitude  
Deformed Var: U, Deformation Scale Factor: \*3.858E+00





# MECA0063: Agenda 2021-2022

Date	Cours	Cours
10/02	General layout of vehicles	Project presentation
17/02	Structural design	Topology optimization
24/02	Transmission 1 (Clutch, MT)	Topology optimization
03/03	Transmission 2 (AT, Differentials)	
10/03	Seminar lightweight design	M. Belhabib (FORD)
17/03	Suspension 1 (Design)	
24/03	Suspension 2 (Technologies)	
31/03	Suspension 3: antidive/antisquat	
08/04	Visit of JTEKT TORSEN	EASTERN HOLLIDAY
14/04	EASTERN HOLLIDAY	
21/04	Suspension 4: Elements	





# Lectures and supervised work

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- Lecture: in hybrid mode
  - In presence (preferred option)
  - Visio via TEAMS
    - <https://teams.microsoft.com/l/meetup-join/19:BYN5V2vT5NrLFjbXuQFRXUwNMLf5uqSyvve3XICcpR41@thread.tacv2/1644440938267?context=%7B%22Tid%22:%2262e13b84-1960-4562-8c7f-72472951da8f%22,%22Oid%22:%222f7aee6f-3e07-4a26-b9e9-7049d03e9eaf%22%7D>
    - + recording





# Lecture notes

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- Copies of the slides
  - Web site [www.ingveh.ulg.ac.be](http://www.ingveh.ulg.ac.be)
    - → Cours → MECA0063
  - TEAMS
    - Notes de cours



# Exams and evaluation

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- Design project (40%)
  - Reports (milestones + final report)
  - Defense (15 minutes presentation + 15 minutes discussion)
- Oral exam → theory (60%)
  - 1 question with preparation with open books
  - Series of sub questions



# Recommended references

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- R. Bosch. « Automotive Handbook ». 5th edition. 2002. Society of Automotive Engineers (SAE)
- G. Genta & L. Morello. "The automotive chassis. Volume 1 Components design. Springer 2009.
- J. Happian Smith. « An introduction to modern vehicle design ». Butterworth Heinemann 2002.
- H. Heisler. « Vehicle and Engine Technology ». 2nd edition. SAE, 1999.
- W. Milliken & D. Milliken. « Race Car Vehicle Dynamics », 1995, Society of Automotive Engineers (SAE)
- H. Naunheimer, B. Bertsche, J. Ryborz, W. Novak. "Automotive transmissions. Fundamentals, selection, design, and application. 2<sup>nd</sup> edition, Springer, 2011.
- J. Reimpell, H. Stoll, J. Betzler. « The automotive chassis: engineering principles ». 2nd edition. 2001, SAE.



# Contact

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