UCL Université catholique de Louvain

LMECA2215

2015-2016

Vehicle System Dynamics

5.0 credits	30.0 h + 30.0 h	1q

Teacher(s) :	Fisette Paul ;
Language :	Français
Place of the course	Louvain-la-Neuve
Inline resources:	> http://moodleucl.uclouvain.be/enrol/index.php?id=8239
Main themes :	Fundamental theoretical notions in view of studying vehicle dynamics For the two families of vehicles (road and railway): - Historical survey of the technology ("dynamics-oriented") - Description and analysis of the typical dynamical phenomena - "Macro" modelling of vehicles: sprung and unsprung masses approach - Specific models related to the wheel/road, wheel/rail contact - Model-based illustration of typical dynamical behaviours and parameter sensitivity analysis "Specific vehicle" dynamics (road vehicles : bicycle, motorcycle, truck and trailer ; railway vehicles: metro with combined wheel/rail and tire, Maglev) and/or particular situations (vehicles on uneven terrain or loose ground, tracked vehicles, ') Multiphysics modelling of vehicles: application to different cases, such as - Pneumatic suspensions in railway vehicles, - Hydraulic suspensions in cars, - Semi-active suspensions in cars. Vehicle dynamics : the "industrial" point of view (railway and road vehicles)
Aims :	In consideration of the reference table AA of the program "Masters degree in Mechanical Engineering", this course contributes to the development, to the acquisition and to the evaluation of the following experiences of learning: -- AA1.1, AA1.2, AA1.3 -- AA2.1, AA2.2, AA2.3 -- AA3.1, AA3.3 -- AA4.1, AA4.2, AA4.3, AA4.4 -- AA5.2, AA5.3, AA5.6 -- AA6.3, AA6.4 By the end of this course, students should be able to understand the kinematic and dynamical phenomena responsible for road and railway vehicle behaviour, in terms of stability, handling and comfort. They will also be able to model them mathematically and build a simulation program: using it, they will point out various vehicular behaviours and emphasize the role of mechanical devices which are at the root of vehicle dynamical performance. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods :	Project defence and oral examination related to the course and the project
Content :	1. Introduction : Fundamental concepts of kinematics, multibody dynamics, vibration and numerical methods in view of analysis of vehicle stability, handling and comfort 2. Railway vehicles - Technology : carbodies, bogies, primary and secondary suspensions, track, track irregularities, vehicle morphology (tramway, metro, high-speed trains, etc.), main concepts: load, Y/Q ratio, critical speeds 3. Railway vehicles - "Macro" models: carbodies/bogies/wheelset/wheel/rail contact simplified model, simplified wheelset model (stability) and vertical model (comfort) 4. Railway vehicles - specific models: wheelset-track 3D model, independent wheel-rail model, wheel-flange second contact, curved track model, primary and secondary suspensions models, etc. 5. Railway vehicles - specific models: (cont.) 6. Railway vehicles - use and interpretation of models : model versus experiment, parameter sensitivity analyses, model-based understanding of the fundamental dynamical phenomena 7. Road vehicles - Technology: suspensions (classification), role of the tire, anti-roll bar system, etc., main concepts: struts, car roll centre, torsion bars, suspension typical motions 8. Road vehicles - "Macro" models : sprung and unsprung masses, geometrical roll centre computation, Ackermann steering geometry 9. Road vehicles - specific models : 3D kinematics of suspensions : McPherson strut, multi-link suspensions, etc., torsion and anti-roll systems, tire/ground modelling : description of the various models (lateral, longitudinal, vertical, combined) and model-based comparison ; flexible modelling of carbodies 10. Road vehicles - specific models: (cont.) 11. Road vehicles - use and interpretation of models : model versus experiment, parameter sensitivity analyses, model-based understanding of fundamental dynamical phenomena (understeering/oversteering, entry curving, steady state curving, comfort criteria with different road profile characteristics

	12. Specific vehicles - Technology and Modelling : bicycles and motorcycles (stability, gyroscopic effects, wheel/ground contact models, '), and/or trucks and trailers (lateral stability, jacknifing), and/or tracked vehicles on loose and uneven terrains (geometrical models, constitutive models, ') 13. Seminar on hybrid modelling: 2 detailed applications (problem - model - results - analysis): these seminars will be closely linked to the research of the CEREM (Centre for Research in Mechatronics of UCL) 14. "Industrial" Seminar: "Railway dynamics, the point of view of the industry" (Bombardier-Transport, France) or "Car suspensions" (Tenneco-Automotive, Saint-Trond, Belgium). Exercises - Projects - Pre-project : to become familiar with the modelling of wheel/ground and/or wheel/rail contact; duration = 3 weeks, software : ROBOTRAN. - Project : modelling of railway or road vehicle behaviours, among the following (non exhaustive) list of subjects (duration = 8 to 10 weeks): - Cars with and without anti-roll bar system : comparison of curve performances - Over/under steering behaviour of a simple car: analysis in entry curving - Modelling of the "jacknifing" phenomenon of a truck+trailer. - Lateral stability of a sidecar or of an ATV - Modelling of a car equipped with an ESP system - analysis of entry curving behaviour - Optimization of passive suspension parameters to improve passenger comfort criteria - Model-based computation of the critical speed of a railway bogie on a straight track (linear, non-linear cases) - Railway : study and modelling of the second-contact (flange contact) - application to entry curving - Modelling of railway bogies with independent wheels (ex. Tram2000): study of the behaviour on a straight track - Modelling and analysis of the " wobble " and " weave " phenomena of a motorbike. Students will work in groups of 2 or 3. They will either use the ROBOTRAN program or a commercial multibody program (SIMPACK or AMESIM), depending on the selected project. Training for using these programs will be organized at the beginning of the semester. Visit to a company - Bombardier-Transport Company : Crespin (France) or - Tenneco-Automotive Company, Saint-Trond, Belgique Examination based on : - project : a plenary session of group presentations will be organized - oral examination (individual) related to the course and the project : students may have the course notes at their disposal.
Faculty or entity in charge:	MECA

Programmes / formations proposant cette unité d'enseignement (UE)				
Intitulé du programme	Sigle	Credits	Prerequis	Acquis d'apprentissage
Master [120] in Mechanical Engineering	MECA2M	5	-	
Master [120] in Electro-mechanical Engineering	ELME2M	5	-	