TIRE TECHNOLOGY EXPO 2027

Tire Mathematical Modelling Short Course

Hanover, Germany | 1–4 March 2027

Abstract

This 4-day course covers the computer modelling of tires within a full vehicle system and is aimed at engineers and researchers working in both industry and academia. The subject matter will be of primary interest to vehicle dynamics engineers, for whom the tire is the primary force and moment generation element on the vehicle. The course is also useful to engineering managers who wish to understand existing tire modelling activity and its challenges, or to successfully implement new tire simulation processes in the workplace.

The course starts with an overview of tire force and moment characteristics and relates these to the physics of the tire-road interaction. Fundamental modelling approaches are discussed in such a way that participants can understand the concepts behind commercially available Tire simulation packages or even attempt their own custom solution. Empirical, data-based tire models and the associated laboratory and field testing of tires for model fitting have a special place in tire force simulation and are also addressed in detail. Finally, several state-of-the-art commercially available tire simulation models are presented, covering both families of empirical and physical models.

Presenters include

Moe Behroozi Amazon/Zoox	**Flavio Farroni** **Andrea Sammartino** University of Naples, MegaRide
Axel Gallrein Fraunhofer ITWM	**Mathieu Grob** **Julien Levray** JEDAi
Joachim Stallmann **Christian Ludwig** Cosin Scientific Software	**Carlo Lugaro** **Willem Versteden** Siemens
George Mavros Loughborough University	**Marco Furlan** Calspan Corporation
Jan Prins JP76 Solutions	**Dirk Engel** HAW Hamburg (Hamburg University of Applied Sciences)
Christian Bachmann fka GmbH, Aachen	**Günter Leister** TMWS Consulting

Course Summary

DAY 1 1 March 2027, 9AM–5PM — Tire Mechanics, Testing & Modeling Fundamentals	
Moderator: Moe Behroozi	
Course 1.1 – Introduction to Tire Mechanics	Moe Behroozi
Course 1.2 – Tire Testing and Characterization	Marco Furlan
Course 1.3 – Physical Tire F&M Modelling: The Building Blocks	George Mavros
Course 1.4 – Terramechanics Tire Modelling	George Mavros

DAY 2 2 March 2027, 8AM–5PM — Tire Models: Commercially focused Application	
Moderator: George Mavros	
Course 2.1 – F-Tire Introduction	Joachim Stallmann, Christian Ludwig
Course 2.2 – CD-Tire Fundamentals	Axel Gallrein
Course 2.3 – MF-Tire/MF-Swift Fundamentals	Carlo Lugaro, Willem Versteden
Course 2.4 – Tire Modelling from OEM Perspective	Jan Prins, Martin Shaw

DAY 3 3 March 2027, 8AM–5PM — Advanced Tire Modeling & Simulation	
Moderator: Moe Behroozi	
Course 3.1 – Finite Element Modelling of Tires | part 1: Fundamentals	Moe Behroozi
Course 3.2 – Finite Element Modelling of Tires | part 2: Application	Moe Behroozi
Course 3.3 – Tire Physical Modelling for Motorsport Applications	Flavio Farroni, Andrea Sammartino
Course 3.4 – Tire Wear: Mechanics, Testing, Characterization and Simulation	George Mavros

DAY 4 4 March 2027, 8AM–3PM — Tire Models for Vehicle Application	
Moderator: George Mavros	
Course 4.1 – The Role of Driving Simulators in Tire Design	Mathieu Grob, Julien Levray
Course 4.2 – Tire Design for Vehicle Dynamics	Moe Behroozi
Course 4.3 – Physics of Tire and Vehicle Interactions	Dirk Engel
Course 4.4 – Tire Regulation, Homologation and Digital Twins	Günter Leister, Christian Bachmann

Day 1 | 1 March 2027 | 9AM–5PM

Tire Mechanics, Testing & Modeling Fundamentals

MODERATOR: Moe Behroozi

Time	Session & Topics	Presenter(s)
09:00	**Course 1.1 – Introduction to Tire Mechanics** • Course introduction • Introduction to Tire Modelling • Simulation Tools • Tire Forces and Moments	Moe Behroozi
10:45	*Break*	
11:00	**Course 1.2 – Tire Testing and Characterization** • How to measure tire performance? • Overview of tire test equipment and test methods • Strengths and weaknesses of common measurement approaches • Automotive vs Motorsports tire testing • From in-door lab testing to the real road	Marco Furlan
12:30	*Lunch*	
13:30	**Course 1.3 – Physical Tire F&M Modelling: The Building Blocks** • The Bush Tire model • A simple model for transient Tire behavior • Friction Thermal Tire modelling	George Mavros
15:00	*Break*	
15:20	**Course 1.4 – Terramechanics Tire Modelling** • The physics of Tire-soil interaction • FE and analytical modelling • Testing and Characterization • Full vehicle implementation	George Mavros
17:00	**Finish**	

Day 2 | 2 March 2027 | 8AM–5PM

Tire Models: Commercially focused Application

MODERATOR: George Mavros

Time	Session & Topics	Presenter(s)
08:00	**Course 2.1 – F-Tire Introduction** • FTire – The physical 3D nonlinear tire simulation model • Outline of model formulation • Interfaces, tools, and results • Extended handling • Thermal and wear model • Flex-rim model • Hard real-time applications	Joachim Stallmann Christian Ludwig
10:00	*Break*	
10:20	**Course 2.2 – CD-Tire Fundamentals** • Closing the gap to structural analysis • Multi-physical aspects of tire modelling	Axel Gallrein
12:00	*Lunch*	
13:30	**Course 2.3 – MF-Tire/MF-Swift Fundamentals** • History of the Magic Formula: 35 years of evolution • MF-Tire/MF-Swift: MF-based modular Tire model • MF-Tool: Tire model parameterization • Tire data acquisition methodologies	Carlo Lugaro Willem Versteden
15:00	*Break*	
15:20	**Course 2.4 – Tire Modelling from OEM Perspective** • Vehicle Development and CAE • Testing of Tires for Purpose of Modelling • Challenges and Vision	Jan Prins
17:00	**Finish**	

Day 3 | 3 March 2027 | 8AM–5PM

Advanced Tire Modeling & Simulation

MODERATOR: Moe Behroozi

Time	Session & Topics	Presenter(s)
08:00	**Course 3.1 – Finite Element Modelling of Tires | part 1: Fundamentals** • FE modelling philosophy • Fundamental understanding of tire mechanical structure • Material testing and modelling	Moe Behroozi
10:00	*Break*	
10:20	**Course 3.2 – Finite Element Modelling of Tires | part 2: Application** • Practical development of Tire FE model • Simulation of static and dynamic Tire performance characteristics • Virtual Tire Development Process using FE modelling techniques	Moe Behroozi
12:00	*Lunch*	
13:30	**Course 3.3 – Tire Physical Modelling for Motorsport Applications** • T.R.I.C.K.: getting experimental Tire interaction curves from vehicle data • RIDElab: managing multi-physics in Tire analysis and modelling • thermoRIDE: a real time physical Tire thermal model • weaRIDE: from road and rubber knowledge to wear and degradation • adheRIDE: an MF-evo formulation accounting for temperature, roughness, viscoelasticity, and wear	Flavio Farroni Andrea Sammartino
15:00	*Break*	
15:20	**Course 3.4 – Tire Wear: Mechanics, Testing, Characterization and Simulation** • Concept and mechanics of tire wear: abrasion, fatigue and frictional wear mechanisms • Wear testing and characterization: laboratory, track and on-road methods • Wear modelling methods: empirical, physical and thermo-mechanical approaches • Wear simulation: coupling friction, temperature and wear to predict tire life	George Mavros
17:00	**Finish**	

Day 4 | 4 March 2027 | 8AM–3PM

Tire Models for Vehicle Application

MODERATOR: George Mavros

Time	Session & Topics	Presenter(s)
08:00	**Course 4.1 – The Role of Driving Simulators in Tire Design** • One tire, but not alone: the tire as part of the ground/vehicle/driver system • The Virtuality: how to combine Virtual and Reality methods • Digital Twins methodology • Tire Modeling philosophy: the right model for the right applications • The driving simulator as the virtual development hub for tire design	Mathieu Grob Julien Levray
10:00	*Break*	
10:15	**Course 4.2 – Tire Design for Vehicle Dynamics** • Tire Max Lat/long capacity: ETRTO guideline, Sidewall utilization • Suspension Kinematics: Camber thrust, Scrub Radius, Kinematic trail • Dynamic Weight Transfer: Longitudinal load transfer, Anti-dive/Anti-squat • Active Safety Systems: ABS control logic, ESC interventions • Ride Comfort Dynamics: Spring/damper stiffness, Road roughness	Moe Behroozi
11:45	*Lunch*	
12:30	**Course 4.3 – Physics of Tire and Vehicle Interactions** • Tread Pattern Engineering: Void ratio, Hydroplaning mitigation • Tire Aerodynamics: Drag reduction strategies, Wheel well airflow • Smart Tire Technologies: TPMS advancements, Real-time friction • Manufacturing Tolerances: Uniformity grading, Mass imbalance • NVH Characteristics: Cavity resonance, Transfer Path Analysis • Transient Tire Self-Excitation: Power-hop, High-frequency NVH • Soft soil dynamics: Vehicle Dynamics interactions • Tire misuse: nonlinear MBS, fidelity FE model	Dirk Engel
14:00	**Course 4.4 – Tire Regulation, Homologation and Digital Twins** • ISO/FDIS 11010-3: Generation process of tyre model parameter • ISO introduction topic (guideline, test and data variations) • Tire standards and regulations • Tire submission and homologation process • Tire performance/industry metrics • Tire Regulation and related compliance requirements • Tire data and requirements for Digital Twins	Günter Leister Christian Bachmann
15:00	**Finish (End of Course)**	