

## OVERVIEW

The course has been designed for automotive/mechanical engineers and researchers, with the aim of reviewing xEV technology and the challenges and opportunities associated with e-mobility. Prof. Rizzoni has been engaged in engineering research and education in e-mobility for over 30 years; this course represents a compendium of material he teaches in a graduate level course at The Ohio State University, and it is designed to provide a comprehensive introduction to the subject matter to automotive/mechanical engineers without significant prior exposure to the subject.

## TIME TABLE

### Tuesday March 18, 2025

9:30 – 10:45 Electrification of Mobility (part I)

10:45 – 11:15 Coffee Break

11:15 – 12:30 Electrification of Mobility (part II)

12:30 – 14:00 Lunch break

14:00 – 15:15 Powertrain Electrification – Electric Drive Systems (Part I)

15:15 – 15:45 coffee break

15:45 – 17:00 Powertrain Electrification – Electric Drive Systems (Part II)

### Wednesday March 19, 2025

9:30 – 10:45 Powertrain electrification – Energy Storage Systems (Part I)

10:45 – 11:15 – Coffee Break

11:15 – 12:30 Powertrain electrification – Energy Storage Systems (Part II)

12:30 – 14:00 Lunch Break

14:00 – 15:15 Electrified Drivetrain Architectures and System Concepts (Part I)

15:15-15:45 Coffee Break

15:45 – 17:00 Electrified Drivetrain Architectures and System Concepts (Part II)

## WHERE?

**Politecnico di Torino**

**Meeting** room Multimedia NORD DENERG

## INSTRUCTION FOR THE REGISTRATION

For the registration, please fill the online form at the following url:

<https://forms.gle/ygXPc7ALyGfZhyaX7>

The course is aimed @ PhD students and young professional



**Politecnico  
di Torino**

Dipartimento Energia  
"G.Ferraris"



**Decarbonizing the  
transportation  
sector: the  
electrification of on-  
road mobility**

**March 18-19, 2025**

**Prof. Giorgio Rizzoni  
Ohio State University**



## Giorgio Rizzoni

### Biography



the Ford Motor Company Chair in ElectroMechanical Systems, is a Professor of Mechanical and Aerospace Engineering and of Electrical and Computer Engineering at The Ohio State University (OSU). He received his B.S. (ECE) in 1980, his M.S. (ECE) in 1982, his Ph.D. (ECE) in 1986, all

from the University of Michigan. Since 1999 he has been the director of the Ohio State University Center for Automotive Research (CAR), an interdisciplinary university research center in the OSU College of Engineering. His research activities are related to modeling, control and diagnosis of advanced propulsion systems, vehicle fault diagnosis and prognosis, electrified powertrains and energy storage systems, vehicle autonomy, safety and intelligence, and sustainable mobility. He has contributed to the development of graduate curricula in these areas, and has served as the director of three U.S. Department of Energy Graduate Automotive Technology Education Centers of Excellence: Hybrid Drivetrains and Control Systems (1998-2004), Advanced Propulsion Systems (2005-2011), and Energy Efficient Vehicles for Sustainable Mobility (2011-2016). Between 2011 and 2016 he served as the OSU Site Director for the U.S. Department of Energy China-USA Clean Energy Research Center - Clean Vehicles. He is currently leading an ARPA-E project in the NEXTCAR program with the aim of advancing energy efficiency in connected and automated vehicles. During his career at Ohio State, Prof. Rizzoni has directed externally sponsored research projects funded by major government agencies and by the automotive industry in approximately equal proportion. Prof. Rizzoni has to date advised 45 PhD and 110 MS students, is a Fellow of IEEE (2004), SAE (2005), and ASME (2022), a recipient of the 1991 National Science Foundation Presidential Young Investigator Award, and of many other technical and teaching awards.

## Decarbonizing the transportation sector: the electrification of on-road mobility

### Overview

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The course will have a duration of 10 hours, in 4 sessions of approximately 2,5 hours each.

### Part 1 Electrification of Mobility

- History of e-mobility
- Energy considerations:
  - Primary energy sources
  - Well-to-tank energy and emissions analysis – electricity and non-petroleum-based fuels are not necessarily carbon-free
- Vehicle energy use and regulatory environment
- Understanding vehicle energy consumption
- Impact of electrification
- Some observations on world vehicle markets
- Challenges and opportunities

### Part 2 Powertrain electrification – Electric Drive Systems

- Introduction to electric drive system
- Properties of traction motors and motor controllers
- Basic principles of operation
- Types of electric machines and power converters
- Torque speed curves and efficiency
- Example of electric drive systems for xEVs

### Part 3 Powertrain electrification – Energy Storage Systems

- Basic definitions, including energy and power density and cycle life
- Lithium-ion batteries – state of the art and current challenges
- Li-ion cell formats and performance characteristics
- Materials for Li-ion cells – current and future directions
- Battery pack design and system integration
- Charging systems
- Battery life and lifecycle
- Market and supply chain considerations

### Part 4 Electrified Drivetrain Architectures and system concepts

- BEV architectures
- Energy management systems
- Regenerative braking
- Drive Quality
- Traction control, stability control and torque vectoring in BEVs

## OSU Center for Automotive Research

The OSU Center for Automotive Research, CAR, is an interdisciplinary research center in the OSU College of Engineering founded in 1991 and located in a 60,000 ft<sup>2</sup> building complex on the west campus of OSU. CAR conducts interdisciplinary research in collaboration with the OSU colleges of Engineering, Medicine, Business, Public Affairs, and Arts and Sciences, and with industry and government partners. CAR research aims to: develop efficient vehicle propulsion and energy storage systems; develop new sustainable mobility concepts; reduce the impact of vehicles on the environment; improve vehicle safety and reduce occupant and pedestrian injuries; increase vehicle autonomy and intelligence; and create quieter and more comfortable automobiles. A team of 45 administrative and research staff supports over 60 faculty, 120 graduate and 300 undergraduate students, and maintains and makes use of advanced experimental facilities. Dr. Rizzoni has led CAR for over 20 years, growing its annual research expenditures from \$1M per year to nearly \$20M today, and engaging CAR in a broad range of technology commercialization activities, start-up company incubation and spin-out as well as providing a broad range of engineering services to the automotive industry. CAR is also the home of the OSU Motorsports program, which supports the activities of 7 student vehicle competition programs: the Buckeye Bullet (holder of FIA electric vehicle land speed records in excess of 300 mi/h), EcoCAR EV Challenge Team, FSAE, Baja SAE, Buckeye Current Electric Motorcycle Racing Team, SAE AutoDrive Challenge II, and Buckeye Solar Car Team.