EV Education Course Program

Wednesday, November 3, 2021

8:30 am – 5:00 pm
Education Course Program – **"Introduction to Electric Vehicles"**
(Separate registration required)

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Course Agenda

(As of October 22, 2021) – Subject to Change.

Please note course instructors will be participating either in-person or virtual during the conference. Those participating with a virtual presentation will be noted in the schedule below.

7:30 am – 8:30 am
Registration and Continental Breakfast

8:30 am – 8:45 am
Welcome and Introductions | Course Program Co-Chairs: Dr. Babak Lotfi, ExxonMobil and Dr. Neil Canter, Chemical Solutions

8:45 am – 9:45 am
Module 1: An Overview of Hybrid, Full Electric and Fuel Cell Vehicles
This presentation will provide an overview of hybrid, battery electric and fuel cell vehicles. The presentation will explain hybridization levels i.e., micro, mild, full, and plug-in, and how they are differentiated by functionalities, battery power requirements, potential fuel economy benefits, and powertrain architectures (series, parallel, series-parallel). Types of engines and driveline systems used in these types of vehicles will also be discussed. These vehicles will be compared against battery electric and fuel cell vehicles including some examples of vehicle name plates related to these technologies available in the market.

Instructor: Arup Gangopadhyay, Ford Motor Company

Arup Gangopadhyay is a Technical Leader in Powertrain Tribology in Energy, Propulsion and Sustainability organization in Research and Advanced Engineering at Ford Motor Company. Arup has been at Ford for over 30 years and his research focuses on improving fuel economy by reducing frictional losses in powertrain and also improving powertrain durability through modifying surfaces of materials, efficient lubrication, and understanding the interaction between lubricant additives and materials. Arup's more recent research includes development of novel lubricants for engines and transmissions and development of coatings for liner-less cylinder bores in engines. He has published over 80 technical papers including a few recognized as best papers and has nine patents. Arup is an STLE member for 30 years and is an STLE Fellow. He has been active in STLE at both the national and local levels, where he has served on the STLE Board of Directors and in several committees, including the Fellows Committee and Annual Meeting Program Committee.

9:45 am – 10:00 am
Break

10:00 am – 11:00 am
Module 2: Hardware Design and Drive Unit: Transmission System, Electric Machine, and Geartrain
[Virtual Presentation]
This presentation will review some of the subsystem and component details that were touched on in Module 1 on the vehicle and system levels. Fundamentally, it will focus on the driveline systems of hybrid and full electric units. It will touch on the high-level basics of the transmissions, the electric motor/generators, and the heart of the geartrains, gears and bearings. Along with their mechanical details, we will discuss some of the tribology aspects and what that means in vehicle electric drives.

Instructor: Michael Tekletsion Berhan, Ford Motor Company Research and Advanced Engineering

Michael Tekletsion Berhan is the Powertrain Gears and Bearings Technical Expert at Ford Motor Company Research and Advanced Engineering. Mr. Berhan has over 25 years in the design, analysis, and integration of gears, bearings, shafts, chains, geartrain systems, and electric motors. He is the chair of the Ford Transmission/Driveline Patent Committee, the Training Lead for Ford Transmission/Driveline Research, and teaches geartrain systems, components, and CAE. Michael has been a member of the SAE Automatic Transmission Technical Committee for 16 years, sponsoring several standards and recommended practices, and served as Editor and revision author for SAE's AE-29 Design Practices book's Gear, Splines, and Chains chapter. He has also served on the AGMA Electric Drive Committee and taught the AGMA class Integration and Trade-offs in Gear and Bearing Systems. Michael received his MS in mechanical engineering from the Massachusetts Institute of Technology and works on the Ford MIT and overall engineering recruiting teams as a Ford Talent Ambassador.

11:00 am – 11:15 am
Break

11:15 am – 12:15 pm
Module 3: Lubricant Requirements for Electric Vehicles (including hybrids, gearbox and eMotor)
This course presents an overview on lubricant requirements for single and multi-speed, direct oil-cooled electric drive unit applications. As traditional lubricant formulation strategies are increasingly restrictive for EV applications, novel lubricant/additive technologies will be needed to meet new requirements and evolving hardware demands. This course will include formulation approach for EV driveline fluids development and fluid properties required in electric drive units. The discussion will briefly cover use of grease in EV applications. Finally, the course will discuss challenges related to electrical and thermal properties as well as compatibility with copper and other insulation materials.

Instructor: Chris Cleveland, Afton Chemical Corporation

Christopher Cleveland is R&D Technical Director at Afton Chemical Corporation where he has worked for 15 years in the area of transmission fluid research and development. Currently, Chris leads the ATF Formulation team, which is responsible for the development of performance additives for the next generation transmission fluids, AT, DCT, CVT, eV, in collaboration with key customers and OEM partners.

12:15 pm – 1:15 pm
Lunch

1:15 pm – 2:15 pm
Module 4: Heat Transfer Fluids and Thermal Management in HEV and EVs (General Overview)
This lecture will begin with a layout of propulsion system architectures in electrified vehicles. The architectures will cover the landscape from micro-hybrid vehicles through mild-hybrid, full hybrid, plug-in hybrid electric vehicles (PHEVs), and electric vehicles (EVs). The flow of energy in the driveline of electrified vehicles will be described through the use of examples from case studies. Typical experimental approaches to gather and analyze the flow of energy will be illustrated. Specifically, the role of thermal management at the vehicle level will be highlighted using specific examples spanning hybrid electric vehicles (HEVs) as well as battery electric vehicles (BEVs). Simulation techniques used for designing the thermal management layout of electrified vehicles will be discussed. The layout of the thermal management systems of typical electrified vehicles (i.e., HEVs and EVs) will be shown using pictures and schematics from real vehicles. Typical battery architectures and associated thermal management strategies will be shown using examples of contemporary EV. Finally, examples of vehicle range testing, as well as methodologies to optimize the range of electric vehicles (via improved thermal management) will be discussed.

Instructor: Thomas Wellmann, FEV North America

Thomas Wellmann has been at FEV for more than 20 years in different roles. Thomas started his career in NVH (noise, vibration, harshness), where he was engaged in multiple projects for powertrain and driveling NVH, including conventional and electrified powertrains. Activities include detailed studies such as driveline torsional analysis and isolation, engine start/stop investigations, hybrid system strategy analysis, with focus on fuel economy and driveline NVH, as well as integration of electric drive units. With focus on transmissions and drivelines, his responsibilities grew to oversee all vehicle and component testing in this area, including projects on driveline efficiency, durability, and vehicle fuel economy for conventional, hybrid electric and fully electrified powertrains. He has published several publications on the topics of driveline electrification of propulsions systems.

2:15 pm – 2:30 pm
Break

2:30 pm – 3:30 pm
Module 5: Thermal management in EVs (Sub-system and Components) ***[Virtual Presentation]***
This lecture will provide a component-specific view of key drivetrain elements of electrified powertrains. Specifically, challenges and solutions from a lubrication and thermal management perspective of electrified drivetrain components will be discussed. Initially, the layout of typical drivetrains for hybrid as well as battery electric vehicles will be described. Examples depicting the integration of electric motors and generators in hybrid

transmissions will be shown. Examples of state-of-the-art single-speed and multi-speed electric drive units will be illustrated. Case study examples showing the use of advanced simulation tools to meet the lubrication and heat transfer needs of such drive units will be provided. Similarly, results from typical component level testing showing the influence of fluid properties on drive unit efficiency will be discussed. The future technology path for inverters, electric machines, and drive units, along with associated thermal management challenges and solutions, will be discussed.

Instructor: Andreas Mayer, FEV North America

Andreas Mayer is Chief Engineer–E-Mobility at FEV North America, with over 20 years in advanced powertrain testing methodologies, calibration and development. His areas of expertise includes E-motor and inverter controls and parametrization, project and engineering management. Andreas has held several roles at FEV, including Subject Matter Expert–E-Mobility; Senior Technical Specialist–Testing Methods; Technical Specialist–Powertrain Testing; Project Engineer–Powertrain Testing; Test Engineer–Base Enginer Calibration; and Test Bench Engineer–Thermodynamics (FEV EU, Germany). He is a State-certified Engineer (EQF Level 6), BBS Germersheim, Germany (automotive engineering) and Certified Instructor (AEVO) IHK Ludwigshafen, Germany.

3:30 pm – 3:45 pm
Break

3:45 pm – 4:30 pm
Module 6: Test Methods for Evaluation of Electric Vehicle (including tribological, thermal and electrical properties)
This presentation will discuss some of the current established test methods for evaluating EV lubricants and coolants, and assess their ability to perform in the unique environment. This will include discussions on high speed performance, non-conventional materials compatibility, thermal performance, and others. The module will also include a discussion on evaluation methods that will need to be developed to enable industry to properly formulate and evaluate fluids for EV applications.

Instructor: Rebecca Warden, Southwest Research Institute

Rebecca Warden is the manager of the Fleet and Driveline Fluids Evaluation Section at Southwest Research Institute (SwRI). Her section focuses on lubricant evaluations for electrified vehicles, automatic transmissions, axles, tractor hydraulic systems, and gear/hydraulic systems in industrial applications. She is the co-project manager for the Advanced Fluids for Electrified Vehicles (AFEV) consortium, which exists to better understand the unique interactions of EV lubricants with the rapidly growing and changing EV market. During her 12-year career at SwRI, Rebecca has been involved with projects ranging from test stand design and development, standardized lubricants testing, and next generation research and development.

4:30 pm - 5:00 pm
Q&A and Wrap Up