Off-Highway Machine Electrification "101"

A training course delivered by Matrix Engineering Consultants.

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COURSE OVERVIEW

This course provides a foundational understanding of high-voltage (HV) electrical architectures and components for electrified off-highway machines such as construction, agricultural, and mining equipment. Participants will explore system-level design principles, component interactions, safety and reliability considerations, routed harness manufacturing, and emerging standards. The curriculum emphasizes practical integration challenges—thermal management, energy optimization, and mechanical-electrical interface design—under demanding duty cycles and harsh environments.

Students will learn to interpret power performance charts, apply standards (IEC, ISO, SAE), and implement quality assurance and diagnostic practices for HV systems. Hands-on exercises reinforce theoretical concepts through real-world scenarios, preparing engineers to design and validate electrified off-highway platforms.

TARGET AUDIENCE

Developed for non-electrification specialists—including mechanical, electrical, and multidisciplinary engineers—who need to expand their knowledge of electric machine architectures, routed systems manufacturing, and standards compliance for electrified off-highway applications.

PREREQUISITES

Participants should be comfortable with basic algebra and general engineering problem-solving. No prior experience with high-voltage or electrification systems is required; the course is designed for those new to electric machine architectures as well as those seeking to strengthen existing knowledge.

IN-PERSON OR ON-LINE LEARNING

Students may choose to attend in-person or via a live on-line stream concurrent with the in-person training. The in-person session will be held in the training facilities at Matrix Engineering Consultants, 12986 Valley View Road, Eden Prairie, Minnesota 55344.

PROFESSIONAL DEVELOPMENT HOURS (PDHS)

- The single day in-person and on-line learning event is worth 7 PDHs.

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Schedule: 8:00 – 12:00 pm

Machine Electrification - Architectures

- *Mobile Machinery Electrical System Design*
- *Hybrid Electrical Machine Architecture*
- *Plug-In Electrical Machine Architecture*
- *Battery Electrical Machine Architecture*
- *Battery Electrical Machine Charging*
- *Swappable BEV Systems*
- *Tethered Electrical Machine Architecture*
- *Electrification & Integration with Mechanical Design*
- *Electrification & Energy Management Basics*
- *Electrification & Component Interaction*
- *Reading / Understanding Performance Curves*
- *Electrification & Thermal Management*

Machine Electrification - Components & Calculations

- *Machine Electrical Safety – Hazards & Control*
- *Circuit Fault Protection & Power Control*
- *Clearance & Creepage*
- *Electrification Safety & Reliability Management*
- *Electrical Power Generation*
- *Battery System Architecture*
- *Electrical Power Storage*
- *Battery Sizing Calculations*
- *Battery Management Systems*
- *Battery Thermal Management*
- *Battery Charging*
- *Electrical Power Transformation*
- *Electrical Power Regeneration Example*
- *Electric Power Conversion Components*
- *HV Power Conversion Calculations*
- *Electrification Component Design and Testing for Reliability*

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Machine Electrification- Routed Systems Manufacturing & Test

- *HV Harness Fabrication / Test Safety Reminders*
- *Typical Fabrication Processes*
- *Quality Assurance and Diagnostics*
- *Diagnostics & Typical Faults*
- *Key Takeaways for Quality Assurance*
- *Harness / Cable Fabrication Automation*
- *Ultrasonics Crimping & Splicing*
- *Harness & Cable Testing*

Schedule: 1:00 – 4:00 pm

Machine Electrification - Emerging Standards

- *Why Standards Matter*
- *Safety - the Core Driver*
- *Emerging Standards Overview*
- *IEC vs. SAE vs. ISO – Who Does What*
- *Common Standards for Electrification*
- *Common High Voltage Standards*
- *Sample NA Standards*
- *California AB1346 (SORE Standard)*
- *High Voltage Equipotential Bonding / Grounding (ISO 14990)*
- *Regional Variations in Standards*
- *Electrification & Environmental Responsibility*
- *Standards for Sustainability in Electrification*
- *Electrification & Emerging Tech and Standards Evolution*
- *How Standards Are Verified*
- *Standards = Reliability + Safety*

Hands-On

- *Lab 1 – Machine Duty Cycle & Utilization*
- *Lab 2 – Battery Sizing for Electrification*
- *Lab 3 – Machine System Configuration*