Electrical System Design for Mechanical Engineers & Technicians

A training course delivered by Matrix Engineering Consultants.

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COURSE OVERVIEW

This course provides mechanical engineers and technicians with a practical foundation in electrical system design for off-highway machines. It introduces essential electrical concepts, components, and architectures without assuming prior electrical engineering expertise. Beginning with passive and active components, circuit protection, and battery technologies, the course builds toward system-level design principles, including power distribution, control strategies, and communication networks (CAN/LIN). Participants will learn basic electrical calculations (Ohm's Law, power, efficiency), explore routed system design (wire/cable selection, sizing, terminations, connectors, harness protection), and address environmental and electromagnetic considerations critical to off-highway applications. Through analogies, hands-on activities, and quizzes, learners will gain confidence in interpreting schematics, specifying components, and applying best practices for reliability and safety. By the end of the course, attendees will be equipped to collaborate effectively on electrical system design projects, bridging mechanical expertise with electrical fundamentals to support modern machine development.

TARGET AUDIENCE

This course is designed for mechanical engineers, technicians, and other non-electrical specialists who work with or support the design, integration, or troubleshooting of electrical systems on off-highway machines. No prior electrical engineering background is required.

PREREQUISITES

This is an entry level technical course which includes equations which need to be solved with algebra. Individuals with some prior experience in electrical system design may find this course easier but there is something for everyone to learn.

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

Module 1: Introduction to Electrical System Components

- *Passive Electrical Components – Analogies to Hydraulic Systems*
- *Simple Electrical Control*
- *Electrical Circuit Protection / Distribution*
- *Electrical Power Generation*
- *Electrical Power Storage*
- *Electrical Control Components*

Module 2: Basic Electrical System Calculations

- *Determining Line Resistance / Kirchoff & Ohm's Law*
- *Simple AC Circuit Calculations*
- *Simple DC RL Circuit Response*
- *Damped Pendulum Analogy*
- *Common Electrical Waveforms*
- *Power Calculations*
- *System Efficiencies*

Module 3: Introduction to Electrical Systems Architecture

- *Mobile Machinery Electrical System Design*
- *Typical Electrical System Controls Breakdown*
- *Mobile Power Distribution Systems*
- *Centralized / Distributed Electro-Hydraulic Control Systems*
- *SAE J1939 Controller Area Network (CAN)*
- *ISO 17987 / SAE J2602 Local Interconnect Network (LIN):*

Schedule: 1:00 – 4:00 pm

Module 4: Introduction to Routed System Design

Section A:

- *High & Low Voltage Wire Selection*
- *Battery Cable Selection*
- *Bus Bar Connection System*
- *Electrical Termination Designs*
- *Electrical Connector Designs*
- *Harness Retention Design Options*

Section B:

- *Wire / Cable Sizing*
- *Wire Color Key*
- *Connector Selection / Application*
- *Electrical System Environmental Considerations*
- *Harness Protection Types*
- *Material Specifications – Ingress*
- *Material Specifications – Flammability*
- *Electrical Magnetic Interference (EMI)*
- *SAE J1939-73 Physical Layer*

Section C:

- *Harness Failure Modes*
- *Electrical Bolted Joint Connections*
- *Cable / Routing Assembly Design Considerations*