Course Description

Discipline/Course: Generation and measurement of high-voltage and high-current signals
Programme for master students of the "Technology and the physics of high voltages" profile

Department of Department of High Voltage Engineering and Electrophysics
Instructor: Dmitry V. Jgun, PhD
Contact details: +7 (3822) 60-61-72,

Learning Outcomes:
Students will be able to calculate currents and voltages for the RLC-circuits in different modes; conduct experiments related to measurement of high-voltage and high-current signals with an oscilloscope and modern instruments; use ready-made software packages for processing of research results.

Course Outline:
Section 1. Introduction to high-voltage and high-current technology;
Section 2. Charging circuits of energy storage devices;
Section 3. Energy storage;
Section 4. Switches for power storage devices;
Section 5. Circuits for generation of nanosecond voltage pulses;
Section 6. Measurement of pulses of high voltage and current.

Course Delivery: one semester

Final Assessment: exam

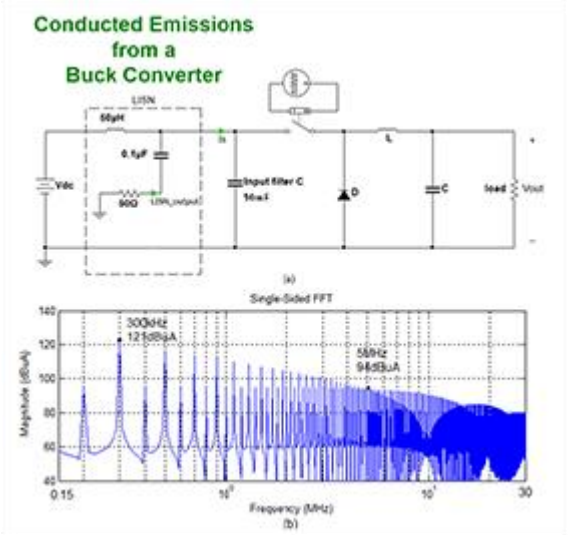
Course Developer: Dmitry V. Jgun, PhD

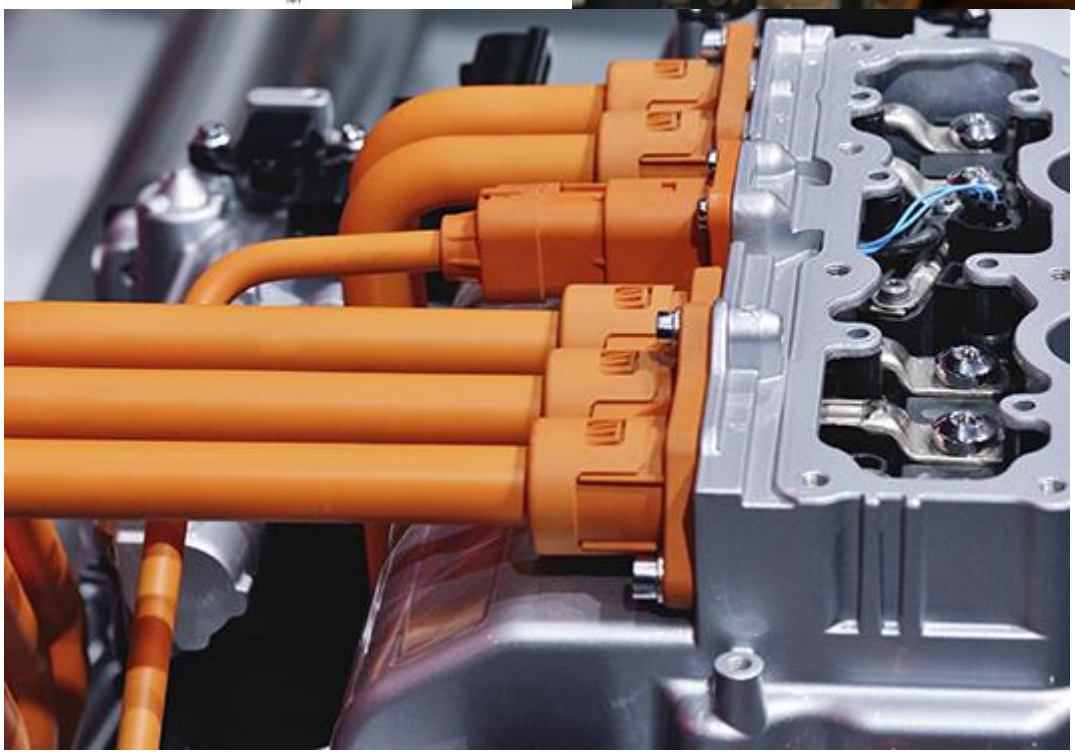
Description

This 1-day course covers fundamental and advanced design concepts related to the design of power electronic circuits for meeting electromagnetic compatibility requirements. In the morning session, basic power electronic circuit topologies and applications are reviewed with a focus on the fundamental properties of these circuits that result in unwanted conducted and radiated emissions. Noise source models are presented and various noise mitigation options are examined. The focus of the afternoon session is on advanced design concepts including grounding strategies, component selection and placement, and methods for maintaining electrical balance. Active noise cancellation techniques applicable in various situations are also presented. Finally, examples of good and bad power circuit designs ranging from low-voltage DC-to-DC converters to 700-volt electric vehicle motor drives are reviewed.

Continuing Education Credit: 0.75 CEUs, 7.5 PDHs

Course Outline





1. Introduction
    - Overview of Power Electronic Circuit Topologies/Applications
    - Key EMC Compliance Issues
2. Conducted Emissions
    - Measurement Equipment and Procedures
    - Primary Sources of Conducted EMI
    - Common-Mode vs. Differential-Mode Emissions
    - Time vs. Frequency Domain Representations of Switching Noise

3. Filtering to Control Conducted Emissions
    - X & Y Capacitors
    - Inductors and CM Chokes
    - Effect of Component Parasitics
    - Design Examples
4. Radiated Emissions
    - Review of EM Coupling Mechanisms
    - Identifying Unintentional “Antennas”
    - EM Shielding for Power Electronics
5. Grounding Strategies for Power Circuits
    - Ground vs. Current Return
    - Path of Least Impedance
    - Common-Impedance Coupling
    - Ground Structures and Grounding Conductors
6. Component Selection and Placement
    - Capacitor and Inductor Options
    - IGBT and MOSFET Options
    - Over-voltage and Over-current Protection
    - Board Layout to Reduce Unwanted Coupling
    - Design Examples
7. Reducing Emissions by Maintaining Electrical Balance
    - Passive Techniques
    - Active Techniques
8. Active Noise Cancellation
    - Overview of Topologies
    - Design Examples
9. Power Circuit Design Examples
    - Low Power DC-DC Converter on a Multilayer Circuit Board
    - DC Motor Driver Employing an H-Bridge
    - 48-Volt 3-Phase Motor Driver
    - 700-Volt Electric Vehicle Motor Driver