

Alternative Drive Systems – E-Mobility -Level -II

Hybrid and Electric Vehicles – Fuel Cell Vehicles

Qualified Electrician for HV systems in Motor Vehicles

Course out line

Sr NO	Content
1	Why do you have to have a high-voltage qualification to be allowed to work on modern vehicles with electric drives?
2	Which basic electrotechnical knowledge is it necessary to brush up on in order to be "fit" for work with the high-voltage technology in modern electric vehicles?
2.1	Introduction.
	Why electrically driven vehicles now
	What is the forecast for the future
	Which technology will prevail: "Hybrid", pure "Plug-in E-drive" or "Fuel cell"?
2.2	Storing electrical voltage
	Nickel-cadmium battery (NiCd)
	NiMH battery ... and its application in electrically driven vehicles
	Lithium technology
	Charging regulations
	Cooling of high-voltage batteries
	Vehicle battery calculation tasks
	The capacitor as a charge and energy accumulator
	Double-layer capacitors in the vehicle
	What are capacitors required for in vehicle electric drives?
	Capacitor for smoothing mixed voltages
	Capacitor charging and discharge curve
	The capacitor in the intermediate circuit of the inverter
2.3	Switching electrical currents electromagnetically
	Speed and rotor position sensors
	Rotors with permanent magnets
	Contactors in electrically driven vehicles and Other safety relays/contactors in electric vehicles
2.4	Electronic components
	The IGBT transistor
	Using the IGBT transistor as an inverter in HV air conditioning compressors
3	What electrical machines and devices are used in electrically driven vehicles?
3.1	Generator

	Three-phase generator (star connection and delta connection)
	High-voltage generator in the vehicle
	Rectifying as the first task of the inverter in electrically driven vehicles
3.2	DC/AC and DC/DC converters
	Voltage generation through stationary induction (transformer principle)
	Circuit diagram of an inverter in the vehicle (including DC/DC converter)
	Structure and function of a simple DC/DC converter –Second task of the inverter: Raising or lowering HV voltage in the vehicle
	Structure and function of a charge pump or a step-up converter in the vehicle
	Function of a DC/AC converter with IGBT transistors
	How does the inverter generate a sinusoidal three-phase current for a controllable rotating field? – Third task of the inverter in an electrically driven vehicle
3.3	Three-phase motor
3.4	DC motor
3.5	Wires, cables, connecting systems, charging devices
	Protection for HV cables
	Wires, special specifications for HV cable
	Chargers for electric and plug-in hybrid vehicles
	Charging stations
	Electromagnetic compatibility (EMC) for HV cables
	Charging cables and connectors for chargers for electric vehicles
	Charging and battery replacement concepts
3.6	Drive concepts
	Overview of different generator and starter systems
	Development of the crankshaft starter generator as a precursor to the Mild Hybrid
	Hybrid vehicle definition, Micro , mild , Full or strong
3.7	Workshop work and diagnosis
	Diagnosis using the workshop tester
	Checking insulation resistance
	Checking HV voltage
	Checking manufacturer-specific HV voltage
	Manufacturer-specific test units
	Mechanical replacement work on high-voltage components
4	What are the hazards in the workshop for mechatronics engineers handling electrically driven vehicles and how are these dealt with?
4.1	Hazard due to the impact of electrical currents
	Physiological effect of electrical current
	Impact on the human organism

4.2	Hazard due to electric arc
4.3	Hazard due to secondary accidents
4.4	Protective measures against electric shock and electric arcs in the public grid and in passenger cars
	Definition/Classification of hazard classes
	Hazard limits
	Structure of electrical networks
	Safety precautions in electrical installations and devices
	Protective measures in passenger cars
	Definition of "HV intrinsically safe vehicle"
	Safety measures when working on high-voltage vehicles
4.5	What to do in the event of accidents, first aid
	Legal principles for assistance services
	Process diagram of immediate life-saving measures
	Self-protection as helper, rescue from danger zones
	Diagram of emergency messages
	Use of an AED (Automatic External Defibrillator)
5	What legal regulations must be taken into account when handling electrically driven vehicles in the workshop? What are the requirements for the workshop personnel?
5.1	Implications of the laws and regulations
	Hazard assessment (risk assessment)
	Determination of the hazard and measures
	Operating instructions – Instructions for use – Product training by manufacturer
	Training of the workshop personnel/trainees
	Electrical disconnection of the affected vehicles (principle)
	Ascertain and document disconnection from voltage
6	Description of the technology and of disconnection using examples from real series production vehicles .
6.1	"Mild Hybrid" example: Mercedes S 400 Hybrid
	Structure of the system with integration in the vehicle
	Components
	Auxiliary units concerned
	Regenerative brakes
	Regenerative braking system (RBS) circuit
	Cooling of the HV units
	Function and display of the flow of energy
	Safety philosophy of the manufacturer
	Disconnecting and ascertaining and documenting disconnection from voltage
6.2	"Full Hybrid" example: Toyota Prius with integration of motor generators in the transmission for the front drive
	Overview of hybrid vehicle

	Structure of the system with integration in the vehicle
	Components and special features of the Toyota Prius
	Tasks of the main components
	Why is an inverter required?
	Design of the combustion engine
	Hybrid drive unit
	Drive and driving situations
	Nomographic diagram
	Operation and display
	12 V power supply and structure of the high-voltage on-board electrical system
	Safety philosophy of the manufacturer
6.3	"Electric vehicle" example: Smart ED (electric drive)
	Brief overview of other electric vehicles
	Components and special features of the smart fortwo ed
	Explanations of the main components
	Disconnecting and ascertaining and documenting disconnection from voltage
6.4	"Fuel cell vehicle" example: Mercedes B-Class F-Cell
6.5	Examples of other hybrid and electric vehicles