

# QUESTIONS FOR THE DIPLOMA EXAMINATION

Study Level: Bachelor

Field of Study: Electric and Hybrid Vehicle Engineering

Basic competencies of field of study (selection of one question only)

1. Fundamentals of classical mechanics - Newton's laws, the laws of momentum, angular momentum and kinetic energy.
2. Conditions of bodies mechanical equilibrium.
3. Resistance to the bodies motion - source, description, effects.
4. Work, power, energy - definitions, mutual relations.
5. The gyroscopic effect - essence, application in technology.
6. Collision of bodies - definition, description.
7. Description of motion of a particle in movable reference frames.
8. Vibrations in mechanical engineering (risks and methods of its elimination).
9. The resonance phenomenon - essence, description, properties.
10. The dynamic vibration absorber.
11. Stress, strain and its relationship for complex loading.
12. Strength calculations of beams (bending moments and shearing forces).
13. Compare Coulomb-Tresca-Guest and Huber-Mises-Hencky criteria for plane stress (bending and torsion).
14. Differences in operation of control systems with open and closed loop.
15. Basic elements of automatic control systems and its characteristics in time and frequency domains.
16. Rods buckling - definition and fundamentals of calculation.
17. Thermodynamics processes of gases (p-V, T-s graphs).
18. Equation of the state for gas.
19. The first and the second law of thermodynamics.
20. The definitions of enthalpy, entropy and specific heat capacity ( $c_p$  and  $c_v$ ).
21. The Ohm's law and Kirchhoff's circuit laws.
22. Electric circuit composed of RLC elements.
23. Question of power factor " $\cos\phi$ " in AC circuits - the power triangle.
24. Torque speed characteristic of DC motor.
25. Torque speed characteristic of AC motor.
26. Types of corrosion.
27. Catalytic effect and its application in automotive industry.
28. Lead-acid cell principle of operation.
29. Electrochemical series of metals.
30. Types of chemical reactions (redox reactions).
31. Overpotentials explanation on the example of hydrogen production using electrolysis.
32. Electrodeposition - explanation on the example of copper or zinc plating.
33. Anticorrosion protection methods and possible risks of corrosion.

Basic engineering competencies of field of study (selection of one question only)

1. Geometric 3D modelling – basic concepts.
2. Basic structures in programming using algorithmic language.
3. Basic concepts of object oriented programming – application.
4. Fe-C alloys – application and differences in properties.
5. Alloys of non-ferrous metal – application and properties.
6. Polymer and composite materials in mechanical engineering.
7. Heat and thermochemical treatments of materials.
8. Differences in manufacturing technology for job production, flow production and mass production.
9. The uncertainty of measurement.
10. Geometric tolerances (discuss the chosen one).
11. Design for manufacturability.
12. General and detailed rules of design - formulation of the optimization task.
13. Screw mechanism efficiency definition based on analysis of its forces distribution.
14. Threaded fasteners bolt steel diameter calculation.
15. Parallel key, spline and wedge connections - applications and calculations.
16. Shaping and strength calculations of welded, soldered and glued joints.
17. Design process of the shafts (substitutive torque).
18. Sliding bearings - design and classification, types of friction, materials.
19. Rolling bearings - classification and methods of its selection, initial tension of angular bearings.
20. Types of clutches - classification and design solutions.
21. Flexible couplings – application, methods of its calculations and design solutions.
22. Basic geometrical parameters of spur gears: gear ratio, modulus, base circle, pitch circle, interference ratio, tooth correction and modification.
23. Main concepts of FEM (definition, shape function, stiffness and inertia matrix, congruent loads), types of finite elements.
24. Classification of signals and the random signals basic characteristics.
25. Gating and filtering of signals.
26. The Fourier and Hilbert transform.
27. Types of sensors used in vehicles.
28. The notch concept and its impact on ultimate and fatigue strengths.
29. The planetary gear set (epicyclic gear).
30. Energy accumulators (different types in dependence on the kind of stored energy).
31. Active and passive safety (discussion on the example of construction machinery or vehicles).
32. Combustion engines thermodynamic cycles.
33. Methods of electric motors starting.
34. Methods of electric motors rotational speed control.
35. Methods of electric motors braking.

Specialization competencies of field of study (selection of one question in the diploma topic dependence)

1. Comparison of controlled and uncontrolled rectifiers.
2. The hysteresis phenomenon discussion on a chosen example (e.g. magnetic, mechanical, etc.). Interpretation of the area inside the hysteresis loop.
3. Functions of the electric drive crucial components (e.g. vehicle).
4. Discussion of regenerative braking in vehicles.
5. Properties of electric direct drive in vehicle (in-wheel motor).
6. Hydrogen fuel cells – its types and principle of operation.
7. Comparison of electrochemical battery and supercapacitor properties.
8. Methods of internal combustion engine fuel consumption minimization in hybrid drives.
9. Functions of the hybrid drive crucial components (e.g. vehicle).
10. Functions of the crucial components of powertrain with hydrogen fuel cell (e.g. electric vehicle).
11. Electrochemical accumulators of energy.
12. Comparison of internal combustion engine and electric motor torque speed characteristics.
13. Principle of operation of transformer and DC/DC converter.
14. Four-quadrant operation of motor drive.
15. Comparison of BLDC and PSMS electric machines.
16. Properties comparison of slow-speed and high-speed electric motors applied in electric vehicle powertrain.
17. Continuously Variable Transmission – its types, principle of operation and control methods.
18. Discussion of different levels of vehicle powertrain hybridization.
19. Comparison of series and parallel hybrid vehicle powertrains.
20. Classification of electric energy converters.
21. Methods of hydrogen production and storage.
22. Photovoltaic cell – principle of operation, technological limitations and application.
23. Vehicle tire adhesion coefficient characteristics.
24. Drag forces of vehicle motion – the power balance.
25. Powertrain as the speed and torque converter.
26. Impact of tire adhesion to the road on the ABS operation.
27. The networks in vehicles.
28. The On Board Diagnostic systems.
29. Main parameters affecting the travelling range of the electric vehicle equipped with elastic PV module on the roof and electrochemical battery.
30. Usefulness of changing the time domain onto State of Charge domain of electrochemical battery in the context of application in electric vehicle BMS - main parameters monitored by the BMS.
31. Constant current charging and discharging characteristics of the battery (ranges of nonlinearity - where is visible domination of activation and concentration polarization).
32. Fuels cells characteristics. Main losses in fuel cells.

33. Charging of the electrochemical battery (its phases and processes during each of phase).
34. The criteria of Li-Ion cell components selection.