QUESTIONS FOR THE DIPLOMA EXAMINATION

Study Level: Bachelor

Field of Study: Mechatronics of Vehicles and Construction Machinery

Basic competencies of the 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 mechanical equilibrium of bodies.
3. Resistance to the motion of bodies - 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 their elimination).
9. The resonance phenomenon - essence, description, properties.
10. The dynamic vibration absorber.
11. Stress, strain and their relationship with 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. Rods buckling - definition and fundamentals of calculation.
15. Differences in operation of control systems with open and closed loop.
16. Basic elements of automatic control systems and their characteristics in time and frequency domains.
17. Fourier transform and Hilbert transform.
18. Laplace transform.
19. Thermodynamic processes of gases (p-V, T-s graphs).
20. Equation of the state for gas.
21. The first and the second law of thermodynamics.
22. The definitions of enthalpy, entropy and specific heat capacity (c_p and c_v).
23. Bernoulli's law.
24. The phenomenon of viscosity (concept, units).
25. Stability of swimming.
26. The Ohm's law and Kirchhoff's circuit laws.
27. Electric circuit composed of RLC elements.
28. Question of power factor "$\cos\phi$" in AC circuits - the power triangle.
29. Characteristic of DC and AC motors.
30. Types of corrosion.
31. Linear, constitutive relations in discrete systems and analogies (mechanical, dynamic, electrical, hydraulic systems).
32. Problems of reducing redundancy in logic circuits.

Basic engineering competencies of the 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 – their 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 selected one).
11. General and detailed rules of design - formulation of the optimization task.
12. Definition of screw mechanism efficiency based on an analysis of distribution of its forces
13. Calculations of bolted connections.
14. Parallel key, spline and wedge connections - applications and calculations.
15. Shaping and strength calculations of welded, soldered and glued joints.
16. Design process of the shafts - substitutive torque, theoretical outline, grading.
17. Critical speeds of rotating shafts.
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. Friction clutches - calculation scheme. Design solutions in vehicles and construction machinery.
21. Flexible couplings - application, methods of its calculations and design solutions.
22. Tension transmissions: types, construction, operation, applications, calculation.
23. Basic geometrical parameters of spur gears: gear ratio, modulus, base circle, pitch circle, interference ratio, tooth correction and modification.
24. Main concepts of FEM (definition, shape function, stiffness and inertia matrix, congruent loads), types of finite elements.
25. Classification of signals and characteristics of random signals.
26. Gating and filtering of signals.
27. Amplitude spectra of polyharmonic and non-periodic signals.
28. Measurement of vibration acceleration.
29. Measurements of stresses and tensions.
30. Hydrostatic transmissions.
31. Hydrokinetic transmissions (single and double range).
32. Energy accumulators (different types depending on the kind of stored energy).
33. Elements of hydraulic (pneumatic) systems and their symbols in the diagrams.
34. Active and passive safety (discussion on the example of construction machinery or vehicles).
35. Combustion engines thermodynamic cycles.
36. The hysteresis phenomenon on the selected example (e.g. magnetic, mechanical, etc.). Physical interpretation of the field within the hysteresis loop.
37. The relationship between information and digital codes in mechatronic systems, e.g. passenger vehicles.
38. Decision making in vehicle control and regulation systems. Provide examples.
39. Basic blocks of the microcontroller (meaning, functions).

40. The principle of operation of the analog-to-digital converter (stages of work, parameters, method of conversion between the physical values and the values obtained from measurements).
41. Microcontroller communication interface (properties, features, parameters - choose an example).
42. Counter circuits of microcontrollers (purpose of application, application possibilities, basic registers, internal structure).

Specialization competencies of the field of study (selection of one question depending on the diploma topic)

1. Vehicle drive system (construction machinery) as a speed and torque converter - criteria of gear selection.
2. Types of gearboxes.
3. Differential gear - principle of operation, kinematics and dynamics, the influence of the blockade on the traction properties of the vehicle.
4. Basic types of suspensions.
5. Selection of stiffness and damping in vehicle suspensions.
6. Basic types of steering gears and the principle of the power steering mechanism.
7. Controlling the operation of DC motors (starting, braking).
8. Controlling the operation of AC motors (starting, braking).
9. Controlled physical parameters of the working medium in the hydraulic / pneumatic system.
10. Types of drive gears used in the construction of vehicles and working machines.
11. Elements of hydraulic and pneumatic drives, symbols on diagrams.
12. Basic functional model of a typical control system, the function of the measurement feedback system and the controller.
13. Basic types of regulators.
14. Ways to improve the stability of control and regulation systems.
15. Definition and tasks of technical diagnostics.
16. Monitoring, diagnosis, supervision - definitions and interdependencies between these concepts.
17. Manipulator: simple and inverse task of kinematics and dynamics.
18. he principle of operation of CCD and CMOS matrices and their functional features resulting from the technology used.
19. Histogram of digital image data and its functional values.
20. Digital image filtering methods.
21. Types of data exchange networks used in vehicles and work machines.
22. Control systems for compression ignition internal combustion engines.
23. Control systems for spark-ignition internal combustion engines.
24. Principle of operation of the Kalman filter (stages of the filtration process and applications).
25. Construction of the vehicle controller.
26. Construction and operation of the CAN network. Arbitration mechanism in the CAN network.
27. The vehicle On Board Diagnostic systems.
28. ABS systems and their impact on tire adhesion to the road.