Problems and questions for diploma exam
at the Wroclaw University of Technology, Faculty of Mechanical Engineering
for Master Programme on Mechanical Engineering and Machine Building's field of study
in specialisation of Automotive Engineering

GROUP (A) – for Bachelor Diploma

1. Define the moments of force with respect to point and axis.
2. Of what equilibrium conditions the reactions in supports for the planar and spatial statically determinate systems
3. What load-carrying structures are called trusses (frameworks) and what methods of determining forces in truss
4. Define the static and mass centre moments.
5. Discuss the principle of energy conservation.
6. Discuss the concept of strength and rigidity condition at the example of tension and torsion.
7. Discuss the concept of safety factor; name several factors affecting its value.
8. Elastic constants of isotropic material.
9. Discuss the phenomena of creeping and relaxation in structural materials.
10. Energy methods – give an example of application for calculating displacements and solving the statically
11. Dislocations, their types, effect on strength properties of metals and characteristic quantities.
12. Fe-Fe3C diagram, phases and structures present and their properties; the effect of carbon content on steel
13. Malleable cast irons, receiving, division and designations, properties.
14. Martensite, its structure and properties, carbon influence.
15. Kinematic pairs: definition, classification.
16. Manipulator: simple and reverse task in kinematics and dynamics
17. Define the real safety factor δ and illustrate it at the simplified Haigh diagram.
18. Statically determinate group.
19. Describe the way of creating the Haigh fatigue diagram and explain its suitability in the machine designing
20. Name the design principles and interpret them.
21. Name the components to be taken into account by safety factor (x_{Re}, x_{Rm}, x_Z), whose value is assumed 'a
22. A condition for self-locking of screw joint and its illustration at inclined plane (evolving of one convolution).
23. Flexible screw joint, its significance and force-displacement (work) diagram.
24. Name and discuss criteria, to be met by a machine shaft.
25. The universal (Cardan) coupling, its build and the way of removing the rotational speed pulsation.
26. Characteristics of the involute and cycloidal gear tooth profiles.
27. Selection criteria for rolling bearings.

28. Geometry of gear wheels (base circle, pitch circle, generating circle, addendum and dedendum circle, module, pitch, transverse pressure (outline) angle, pressure angle, line and section of pressure, tooth contact ratio)
29. What is the essence of finite element method (FEM).
30. Materials used for casting moulds.
31. Basic movements in cutting machine tools.
32. Discuss the processes of forging, extruding and rolling.
33. Difference between cold and hot rolling.
34. Role of friction in plastic working processes.
35. Electrodischarge machining. Methods of screw thread production.
36. What is the difference between cast steel and cast iron?
37. Draw and describe the diagrams of steel tension with yield point and creep limit.
38. What is the heat-affected zone and what is its impact on welded joint properties? What welding methods are
39. Specify the differences between MAG and MIG arc welding methods in protective gas and application of the
40. What is the pressure welding, name the learned methods.

GROUP (B) – for Master Degree

1. Discuss the principle of preparatory works.
2. Dynamic equations for flat (planar) rigid body movement (derivation from the general dynamics equation).
3. Discuss the application of the type II Lagrange equations.
4. Discuss the free vibrations in mechanical systems, forms of vibrations and resonance frequencies.
5. Strengthening mechanisms and effects of their application at the example of selected aluminium alloys.
6. Strengthening mechanisms and effects of their application at the example of selected copper alloys.
7. Alloy micro additions and their role in modern high-strength low-alloy steels (HSLA).
8. Types and parameters of reinforcement deciding on composites properties.
9. When the classic strength, and when the brittle cracking mechanics or the mesomechanics of slip cracking are
10. What is the difference between brittle cracking of crack-free materials and those with cracks? Which case is
11. Based at what material parameter we can make a diagram of residual strength for high-strength materials with
12. Give the formula for excess penetration bead criterion before cracking and graphical interpretation of that
13. Technical and operational characteristics of machine tools.
14. Specific requirements for main motion drives.
15. Characteristic features and designation of basic machine tool types.
16. Machines and equipment in automatic casting lines.
17. Division of power presses, their basic sizes and structural features.
18. Equipment for welding with consumable and nonconsumable electrods – principle of operation.
19. Resistive and frictional pressure welding machines – characteristics.
20. Functions of robots at automatic assembly lines.

21. High-speed cutting.
22. Principle of laser operation.
23. What experimental methods for strain analysis do you know?
24. Give examples of computer systems for dynamic analysis and discuss their calculation capacities.
25. Describe a procedure of building a computer model of mechanism.
26. Give reasons for calculating mobility (degrees of freedom) for a multi-member system before initiating
27. What is PLC and what are its applications?
28. What is CNC and what is its designation?
29. Discuss the course of signals in hydrostatic systems controlled by proportional hydraulic components.
30. What is the idea of LS (load sensing) control in the machines with hydrostatic drive?
31. Types of locomotion in land vehicles: examples, advantages and disadvantages, the analogies in nature.
32. Show the impact of limb length and step length on energy consumption in walking motion.
33. Using the axioms in mechanics show why a vehicle is moving.
34. The problem of wheel rolling resistance, definitions, qualitative impact of factors at rolling resistance.
35. Definition of the driven wheel and breaking wheel slide.
36. Oversteering and understeering of a vehicle.
37. Differential gear, types, its kinematics and dynamics.
38. Steering systems in vehicles: without servo, with partial servo and with full servo – examples and simplified
39. Advantages and disadvantages of wheel and caterpillar chassis.
40. Resistance to motion and traction forces of a caterpillar vehicle in relation to a wheel vehicle with two-axis

GROUP C – for specialisation

1. Show constructional and functional structures main systems in vehicle.
2. Describe all resistances existing during vehicle operation.
3. Why does a transmission in the car have to be used ?
4. How does an electronically controlled dual clutch work ?
5. Describe and explain how each of an ABS component works.
6. What are the main aids of aerodynamics under body of a vehicle ? Give an example to support your answer.
7. Tell some ways to classify suspension systems.
8. What will the legislative measures in the EU be regarding to new car CO_2 emissions (for each manufacturer)?
9. Make decomposition of engine to show a lubricating system.
10. Explain the idea behind the use of VarioCam.
11. You are in a team at the development centre of a company building truck engines. What kind of solutions would you consider in order to reduce NOx emission generated from the engines?
12. Show the trends in internal combustion engine technology to improve efficiency.
13. How the second law of thermodynamics affects the working of the combustion engine ?

14. Show the advantages of the Common Rail system.
15. Why are engines noisy and how can the noise be reduced ?
16. What are the predictions about how long crude oil will last for fuel manufacturing ?
17. Explain the Fischer-Tropsch process to get the engine fuel.
18. Show main properties of liquid engine fuels and explain their meaning.
19. Why CNG is named the green fuel ? What are the main advantages and disadvantages of CNG ?
20. What is difference between Cetane index and Cetane number ?
21. What are toxic components of the engine exhausts? Describe the causes of their forming in the combustion chamber.
22. Describe the path of End-of–Life Vehicle (ELV) recycling.
23. Explain, why After Shredding Residues (ASRs) is the weak point of End-of Life Vehicles (ELV) recycling ?
24. Present the characteristics of process of charge and discharge of battery and ultracapacitor.
25. Present and describe output waveform of voltage and current of two pulse control rectifier with the load RL.
26. Present waveform of output current of chopper, mark the current of thyristor and freeweeling diode, mark
27. Does a Series Hybrid Electric Vehicle need to be equipped with a startermotor? Explain with a schematic
28. Explain the Parallel Hybrid drive-train in vehicle.
29. What is the disadvantage of the HSD concerning the overall efficiency of the car ?
30. What are the main differences between narrowband and wideband lambda sensor ?
31. Show differences between CAN 2.0A and 2.0B standard.
32. What is the difference between NTC and PTC thermistor ?
33. What is the different between bus and star topology ?
34. Describe half and full duplex communications.
35. Why knock sensor is so important and how it works?
36. What is HUD and how it works?
37. Give the area of knowledge according to Project Management Body Knowledge.
38. Show and describe the motivation factors for effective work.
39. Describe scheduling by „Top-down” and „Bottom-up” methods.
40. What does it mean progressive calculation of time estimation in project management ?