

Mechanical Engineering, undergraduate studies
specialisation: Design and Production Engineering - questions for
diploma exam
Academic Year 2024/2025

1. Equilibrium conditions of a force system.
2. Ideal and real constraints and their reactions.
3. The equations of solid dynamics.
4. Principles of mechanics: momentum and impulse, energy and work, angular momentum and angular impulse.
5. Friction and rolling resistance.
6. Simple and complex strain condition.
7. Thermal and assembly straining.
8. Fatigue strength of materials.
9. Material strength hypotheses.
10. Surface buckling.
11. Characteristics of the four groups of construction materials.
12. Definition, characteristics and applications of steel.
13. Definition, characteristics and applications of cast iron.
14. Types and applications of aluminium alloys.
15. Types and applications of copper alloys.
16. Phase diagrams of metal alloys.
17. Thermal processing: basic types.
18. Thermo-chemical processing: basic types.
19. Principal methods of examination and research of materials.
20. Characteristics of the forms of materials destruction.
21. Shaping the properties of a material through plastic working.
22. Methods of the dislocation of atoms in solid bodies.
23. Characteristics of the basic properties of materials.
24. Structure of ceramic materials.
25. Production and shaping of ceramics.
26. Isothermal transformation diagrams.
27. Electrical properties of materials.
28. List and discuss the factors considered when selecting the value of the safety factor in strength calculations.
29. Determination of allowable stress for static and variable loading.
30. Method of strength evaluation of fit bolts and preloaded bolts when the joint is loaded in shear (transverse to bolt's axis).
31. Influence of components' stiffness (fastener and member) on the behaviour of a preloaded bolted joint in variable tension loading (axial).
32. Types of shaft-hub connections, advantages and disadvantages of the various types.

33. Explain the main functions of flexible components in mechanical devices, give and discuss a few examples.
34. Methods of achieving fluid friction in slide bearings.
35. Rolling bearings - types, characteristics, selection methods, service life determination.
36. Types of mechanical transmissions, principles of use and characteristic features.
37. A gear wheel with an involute profile - characteristics and geometrical parameters of the wheel.
38. Distribution of forces in helical and spur gears.
39. Fillet and butt weld strength calculations.
40. Examples of the positive and negative role of friction in mechanical systems.
41. Computational model and design method for compression helical spring.
42. Start-up couplings - their role in the drivetrain, examples of design (sketch).
43. Flexible shaft couplings - their role in the drivetrain, examples of design (sketch).
44. Rigid shaft couplings - their role in the drivetrain, examples of design (sketch).
45. Preload in tapered roller bearing systems - role, implementation methods, impact on bearing system life.
46. Potential forms of key connection (shaft-hub) failure vs its computational model.
47. Advantages and disadvantages of plain bearings with fluid friction compared to rolling bearings.
48. Thermal equation of the condition of a perfect gas.
49. Caloric equation of the condition of a perfect gas.
50. First law of thermodynamics.
51. Second law of thermodynamics.
52. Ideal gas processes.
53. Carnot cycle and its efficiency.
54. Comparative thermodynamic cycles of heat engine.
55. Thermodynamic cycle of a vapor compression refrigerator.
56. Thermodynamic cycle of a vapor compression heat pump.
57. Thermodynamic cycle of a steam power plant.
58. Methods of increasing the efficiency of Clausius-Rankine cycle.
59. Isobaric process of dry gas humidification.
60. Parameters characterizing a humid gas.
61. Processing of air in thermal comfort applications.
62. Heat transfer mechanisms.
63. Thermal and electrical analogy in issues related to heat transfer.
64. Upper and lower calorific value of fuels.
65. Bernoulli's principle.
66. Methods of determining the losses in pipelines.
67. Design for manufacturability of machine part construction.
68. Flexible manufacturing systems.
69. Methods of shaping the surface in machining.

70. Quality assessment criteria of a product in a technological process.
71. Fine machining methods and their significance in machine construction.
72. Computer-aided design of technological processes using CAD/CAM/CAE systems.
73. The influence of the serial production of goods on the degree of automation (robotization) of manufacturing processes.
74. The meaning of the rigidity of a working system MCWT (Machine tool, Chuck, Workpiece, Tool) in fine machining.
75. The principle of the database redundancy in machine technology.
76. Selecting the methods of manufacturing of machines with the ecological criteria in mind.
77. Joining processes.
78. Weldability of steel, cast iron and cast steel.
79. Methods of arc welding of metals.
80. Characteristics of resistance welding and friction welding methods.
81. Thermal cycle of welding.
82. Welding stresses and welding distortions.
83. Welding imperfections.
84. Methods of assessing the quality of welded joints.
85. Methods of repair of welded structures.
86. Cracking of welded joints (types, characteristics).
87. Characteristics and construction of welding power sources.
88. Manufacturing techniques of cast machine parts.
89. Characteristics of metal forming processes.
90. Causes and effects of emitting harmful substances into the atmosphere.
91. Mechanical methods of purification and renewal of water.
92. Methods of examining and researching ecological losses and benefits.
93. The definition, classification and basic properties of biomaterials.
94. Classification of protective coatings.
95. Energy storage systems.
96. Components of the hydropower plant and their functions.
97. Operating parameters and performance characteristics of hydraulic turbine.
98. Types of pumps and their working principles.
99. Effect of using fossil fuels on climate change.
100. List natural energy resources and describe the benefits of using them.