List of examination questions on the educational program
8D07108 / 8D07102 - "Innovative engineering of technological machines"

Module 1

1. Explain the principles of classification of machine joints. Which types are most frequently used and why?
2. Describe the physical nature and purpose of threaded joints. How is reliability and self-locking ensured?
3. What is the difference between plain bearings and rolling bearings? Provide examples of applications.
4. Justify the choice of material and heat treatment for gear wheels.
5. What are tolerances and fits? How do they affect the accuracy and interchangeability of parts?
6. What are the basic principles of calculating shafts for strength and stiffness?
7. Explain clutches: their purpose and main types. What distinguishes compensating from safety clutches?
8. What is the structural peculiarity of springs as elements in mechanical systems?
9. What design measures are used to increase wear resistance of movable joints?
10. What are the criteria for reliability and durability of machine components?
11. Explain the nature and application area of belt drives.
12. Why is fatigue analysis important in machine design?
13. Define a "kinematic pair" and give its classification.
14. What is the factor of safety, and how should it be considered in calculations?
15. What are the main principles of manufacturability in part design?
16. What is included in the sketch and technical design stages of a machine?
17. Describe the structure and content of the technical specification for machine design.
18. What methods are used to generate technical solutions during design?
19. What principles guide the selection of a drive mechanism based on the machine’s purpose?
20. What is machine layout? What factors influence its selection?
21. Explain the concepts of modularity and standardization in machine design.
22. What are the stages of functional cost analysis in design?
23. What are the specifics of designing assemblies considering their operating conditions?
24. What is ergonomics in mechanical engineering, and how is it considered in design?
25. Explain the role of the reliability principle in the machine design process.
26. Describe the algorithm for designing a gear transmission.
27. How do you select materials and hardening techniques for elements under impact loads?
28. How is the design of welded joints in machines carried out?
29. What is the difference between intuitive and parametric design approaches?
30. What is the computational experimental method, and where is it applied?

31. Define a machine's "lifetime" and its components.
32. Which software tools are used during the design stage?
33. How does standardization influence the design process?
34. How are environmental considerations incorporated into machine design?
35. What are the design specifics of machines intended for extreme conditions?
36. What is manufacturability, and how can it be evaluated?
37. Explain the stages of developing a machining process for a part.
38. What are the principles for assigning datum references in machining and assembly?
39. What is the difference between technological and design datum references?
40. What are the main methods of obtaining blanks in mechanical engineering?
41. How does the choice of machining method affect productivity and accuracy?
42. What is the purpose and classification of jigs and fixtures in manufacturing?
43. What criteria are used to select cutting parameters?
44. What is the difference between route sheet and operation sheet documentation?
45. How is dimensional accuracy ensured in mass production?
46. What are the features of multi tool machining?
47. How is the rational sequence of operations chosen in a manufacturing process?
48. Define surface roughness and explain its measurement methods.
49. What is a production cycle, and how is it optimized?
50. What is the role of quality control in manufacturing technology?

Module 2

1. What criteria must be considered when selecting a bolted joint for vibrating conditions?
2. In which situations is it preferable to use an interference fit?
3. What features determine the type of rolling bearing for a medium-loaded horizontal shaft?
4. What parameters influence the choice of sliding bearing for a low-speed rotation unit?
5. What justifies the use of a keyed joint under periodic reverse loading?
6. When is a splined joint used instead of a keyed one?
7. What requirements apply to the materials of gear wheels for high power transmission?
8. Explain the principles of selecting the gear module in transmission design.
9. Why are helical or herringbone gears used to reduce transmission noise?
10. In which cases is a worm gear preferable over a spur gear?
11. What factors influence the choice between single-start and multi-start worm gears?
12. How is a belt drive selected based on center distance and equipment layout?
13. What determines the pulley design and method of belt attachment?
14. What are the advantages of V-belts over flat belts?
15. What design features are considered when selecting chain drives for transport systems?

16. Why is an elastic coupling selected when shafts are slightly misaligned?
17. What types of springs are used in machines, and how is the specific type selected?
18. What are the requirements for selecting a braking system for emergency stop mechanisms?
19. What factors are considered in selecting the friction lining material for brakes?
20. When are band brakes preferable, and when are shoe brakes more suitable?
21. What parameters determine the layout scheme of a machine at the conceptual design stage?
22. How does the operating environment affect the selection of construction materials?
23. What design measures increase the rigidity of a machine frame?
24. What factors influence the selection of shaft cross-sectional shape and size?
25. How do stress concentrators affect part design, and how can they be minimized?
26. How is maintainability ensured during assembly unit design?
27. In what cases are welded structures used instead of cast or forged ones?
28. How is interchangeability of parts ensured during machine assembly?
29. What fits and tolerances are used in movable joints, and why?
30. By what criteria is the drive type (electric, hydraulic, pneumatic) selected in machine design?
31. How is the type of transmission (gear, worm, belt) selected depending on operating conditions?
32. What design elements ensure accurate positioning of parts during assembly?
33. What is the role of preloads and clearances in machine parts, and how are they assigned?
34. What methods are used to improve vibration resistance in structures under variable loads?
35. How is thermal expansion of materials considered in machines operating at high temperatures?
36. What principles guide the selection of machine housing material under impact loads?
37. In which cases is it permissible to reduce the safety factor and why?
38. What justifies the need for lightweight structures in mechanical engineering?
39. What parameters influence the shape of stiffening ribs in mechanical designs?
40. Explain how the product life cycle stages affect design decisions.
41. What factors influence the choice of blank type (casting, rolling, stamping) in process planning?
42. How are machining reference bases assigned for accurate processing of housing parts?
43. What is the principle of minimum setups in process design?
44. What factors are considered when choosing a hole-making method (drilling, boring, reaming)?
45. In what cases are fixtures used during machining, and how do they affect accuracy?

46. How is the order of machining operations determined considering system rigidity and accuracy?
47. What criteria are used to select cutting parameters for various structural steels?
48. When is heat treatment necessary in the technological process chain?
49. What methods are used to control geometric parameters of complex surfaces?
50. How is surface roughness ensured in fine grinding and finishing operations?

Module 3

1. General principles of scientific research.
2. Classification of scientific research.
3. Main stages of scientific research.
4. Object and subject of research.
5. Main sources of scientific information.
6. Types of research work.
7. Empirical and theoretical methods of cognition.
8. The principle of consistency in scientific research.
9. Heuristic methods in scientific knowledge.
10. Empirical level of scientific knowledge, its features and role.
11. The structure of empirical knowledge: object, forms, methods.
12. Observation as a method of scientific knowledge, its types.
13. Experiment as a method of scientific knowledge.
14. Stages of experimental research.
15. Concepts of scientific direction, scientific problem and topic.
16. Search for scientific information, methods and tools.
17. Modeling as a scientific method.
18. Numerical modeling methods.
19. Statistical methods for analyzing research results.
20. The relationship between experiment and theory.
21. Theoretical methods of cognition.
22. Methods for processing experimental data.
23. General theoretical research methods.
24. Experimental research methods.
25. Methods for constructing scientific theory.
26. General diagram of the sequence of research.
27. Methods of empirical research.
28. Methods of theoretical research
29. Objectives of theoretical research.
30. Concepts of model, modeling.
31. Basic principles of experimental planning.
32. Main stages of the computational experiment.
33. Types of experiment.
34. The concept of a scientific hypothesis.
35. Classification of general scientific methods.
36. Theoretical level methods in scientific research.

37. Empirical methods in scientific research.
38. Physical modeling in scientific research.
39. Mathematical modeling in scientific research.
40. Computational experiment in scientific research.
41. Methodology for statistical processing of data from experimental studies.
42. Correlation analysis of experimental data.
43. Regression analysis of experimental data.
44. Analysis of variance of experimental data.
45. Forms of representation of mathematical models.
46. Main stages of mathematical modeling.
47. Simulation modeling in scientific research.
48. General principles of process modeling.
49. The principle of integrity in scientific research.
50. The principle of objectivity in scientific research.

List of recommended literature for exam preparation

1. Бышов Н.В. и др. Основы инженерного проектирования. / Кравченко А.М., Борычев С.Н., Кравчук Н.В., Андрющенко Е.И. —Рязань: РГАТУ, 2010. — 289 с.
2. Белозёров Б.П. и др. Методология конструирования: учебное пособие / Б.П. Белозёров, В.Л. Бибик, А.Б. Ефременков, Ж.В. Ефремова; Юргинский технологический институт. - Томск: Изд-во Томского политехнического университета, 2012. - 196 с.
3. Чернышев В.В., Панасенков А.П. Детали машин и основы конструирования. Методологические основы конструкторского проектирования. Учебное пособие. — Тверь: Тверской государственный технический университет (ТГТУ), 2016. — 148 с.
4. Евдокимов А.П., Громыко А.Н. Детали машин и основы конструирования. Учебник. — М.: РГУ нефти и газа имени И.М. Губкина, 2021. — 176 с.
5. Кравченко И.Н. и др. Основы надежности машин: Учебное пособие для вузов. Часть 1 - М.: Изд-во, 2007. - 224 с.
6. Гольдшмидт М.Г. Методология конструирования. Учебное пособие. - Томск: Изд-во ТПУ, 2007. - 173 с.
7. Прейс В.В. Основы методологии проектирования технологических машин и оборудования. Учебник. — Тула: Тульский государственный университет, 2017. — 216 с.
8. Абдулханова, М.Ю. и др. Механическое оборудование предприятий стройиндустрии. Учеб. пособие / М.Ю. Абдулханова, А.М. Колбасин, В.И. Марсов. – М.: МАДИ, 2014. – 120 с.
9. Сурашов Н.Т., Гудович М.И. Подъемно-транспортные машины - Алматы: КазНТУ, 2012. -322 с.
10. Рачков Е.В. Машины непрерывного транспорта. Учебное пособие. - М.: Альтаир-МГАВТ, 2014. - 164 с.
11. Лукашкин Н.Д., Кохан Л.С., Якушев А.М. Конструкция и расчет машин и агрегатов металлургических заводов. Учебник для вузов. — М.: Академкнига, 2003. — 456 с.
12. Фастыковский А.Р. Оборудование прокатных цехов. Учебное пособие — Новокузнецк: СибГИУ, 2015. – 208 с. — ISBN 978-5-7806-0448-8.
13. Пуляев С.М., Степанов М.А., Кайтуков Б.А. и др. Механическое оборудование и технологические комплексы: учебное пособие ¬ М-во образования и науки Рос. Федерации, Моск. гос. строит. ун-т. Москва : МГСУ, 2015. 480 с.
14. Салтыков В.А., Семенов В.П., Семин В.Г., Федюкин В. К. Машины и оборудование машиностроительных предприятий,: учебник. — СПб.: БХВ-Петербург, 2012. — 288 с.
15. Семиглазов В.А. Основы научных исследований. Учебное пособие. — Томск: Томский государственный университет систем управления и радиоэлектроники, 2022. — 73 с.

16. Шумаев В.В. и др. Методы научных исследований. Учебное пособие / В.В. Шумаев, А.В. Поликанов, А.В. Мачнев, А.А. Орехов, Т.Г. Дорофеева, А.И. Зябиров. — Пенза: РИО ПГСХА, 2016. — 245 с.
17. Кузнецова В.Н. Технология научных исследований. Учебное пособие. — Омск : СибАДИ, 2017. — 181 с.

Essay topics

1. Modernization of existing equipment: engineering approaches and solutions.
2. Engineering responsibility in the design and operation of machines.
3. Current challenges of standardization and unification in mechanical engineering.
4. Influence of production factors on the design of machines and mechanisms.
5. The role of engineering calculations in ensuring machine reliability.
6. Interdisciplinary approach as the foundation of engineering for technological machines.
7. Stages of evolution in the design of technological machines and their practical significance.
8. Transition from prototype to industrial implementation: challenges and solutions.
9. Design strategies to increase the service life of wear-prone machine components.
10. The role of technical diagnostics in the modernization of equipment.