Entrance test examples

1. Differential calculus. fundamental theorems of differential calculus

2. Application of differential calculus to the study of functions, constancy, monotonicity, extremum, convexity, inflection points and geometric applications.

3. Integral calculus. A definite Riemann integral over an interval. The existence of an integral.

4. The integrability of a continuous function; The integrability of a bounded function with a finite number of discontinuity points. The integrability of a monotone function.

5. Theorems on the mean value of an integral. Replacement of a variable in a definite integral.

6. Integration by parts. The Newton-Leibniz formula.

7. Differentiability of functions of several variables. Private derivatives. Full differential.

8. A sufficient condition for differentiability. A sufficient condition for the equality of mixed derivatives.

9. The integral calculus. Integral equations of Fredholm and Voltaire of the second kind.

10. Taylor's formula. The local extremum; a necessary and sufficient condition for a local extremum.

11. The theorems of existence, continuity and differentiability of an implicit function. The conditional local extremum; The method of undetermined Lagrange multipliers.

12. Numerical series, convergence and the sum of a number series; The Cauchy criterion;

13. Functional sequences and series, the uniform convergence; Signs of uniform convergence;

14. Formal power series.

15. Linear spaces and their subspaces. Basis and dimension.

16. Bilinear and quadratic forms in linear spaces. Reduction of quadratic forms to the normal form.

17. Reduction of the linear operator matrix to a Jordan form.

18. The first-order differential equations. The existence and uniqueness theorem for the solution of the Cauchy problem.

19. Linear systems. The Wronskian determinant. The Liouville's theorem.

20. The second-order linear differential equations in the partials of the second kind, their classification. The Dirichlet problem for the Laplace equation.

21. Events and their probability. Definitions of the probability of events, set-theoretic, classical, statistical, Kolmogorov's axiomatics.

22. Full-probability and Bayesian formulas. The schemes of independent Bernoulli trials, asymptotic formulas for calculating binomial probabilities (Moivre-Laplace, Poisson).

23. Random variables. Distributions of random variables; Discrete distribution, absolutely continuous distribution.

24. Distribution function and its properties. Density of distribution. Classical distributions of Bernoulli, binomial, Poisson, uniform, normal and exponential.

25. The properties of point estimates of parameters. The estimates of the mathematical expectation and population variance in sampling.

26. Testing the hypothesis of the type of distribution. The method of moments for estimating the distribution parameters. The Pearson's criterion.

27. Random variables. Numerical characteristics. The correlation coefficient, its properties. The sample correlation coefficient.

28. The regression analysis. Checking the significance of the linear model using the Fisher criterion. Checking the significance of the linear model with the help of Student's test.

29. The marginal distribution laws. The initial and central moments. The Gaussian (one-dimensional and multidimensional) distribution and the distributions associated with it.

30. The functions of random variables. Types of convergence of a sequence of random variables.

31. The law of large numbers; Chebyshev and Bernoulli theorems. The central limit theorem. The correlation coefficient. The concept of a random process. The classification of random processes.

32. Stationary random processes. The Gaussian stationary process.

33. Ergodic processes. The correlation theory. The spectral decomposition of stationary processes.

34. the Markov chains. The Markov processes. The continuous Markov process.

35. The Kolmogorov equation. A solution of the Kolmogorov equation for the simplest cases.

36. Basic logical structures of the high-level programming languages.

37. Relational algebra and its role in creating data manipulation languages. Relational operations. Examples of use.

38. Database design. Reduction of tables to the first, second and third normal forms. The Boyce-Codd normal form. An example.

39. The concept of memory, types of computer memory (ROM, RAM, CMOS, FLASH, CACH-memory).

40. The purpose and operation of the video controller and monitor. Their key technical characteristics. Adjusting the video mode and video page.

41. The arrangement and setup of the memory on optical disks (CD ROM, CD RW, DVD ROM). The key technical characteristics of discs and drives.

42. The main tasks solved by LAN. The OSI model. The physical and channel levels of the LAN configuration.

43. Physical and logical network topologies. Various ways of accessing the transmission medium. The main devices operated at these levels.

44. The computer vision fundamentals, the model of perception, the vision of man and computer.

45. The primitive function. The definite integral. The Newton-Leibniz formula. Curvilinear and multiple integrals.

46. Number series, partial amounts. Functional series. Formal power and trigonometric series. Integration and differentiation of series. The signs of convergence of numerical series.

47. Ordinary differential equations and the methods for their solution.

48. The event. Types of events. The concept of probability of an event.

49. Numerical methods for solving a linear algebraic equations and non-linear systems of equations. Direct and iterative methods.

50. Numerical integration and differentiation. An example.

51. Numerical solution of differential equations of mathematical physics.

52. Stages of mathematical modelling, principles of construction and basic requirements to mathematical models of systems.

53. The logical structure of models and the general scheme of development of mathematical models.

54. Formalisation of the system functioning. The forms of representation of mathematical models.

55. Construction of modelling algorithms, formalisation and algorithmisation of processes.

56. Simulation models and statistical modelling on a computer.

57. Goals and tasks of research of mathematical models of systems, an estimation of accuracy and reliability of modelling results.

58. The control concepts and control systems (CS). The problems of the control theory. Principles of control. The classification of control systems. Closed and open CS.

59. Reviewing the basic properties of linear CS, stability, invariance, sensitivity, controllability and observability.

60. The transfer functions of open and closed CS. The Laplace transform.

61. Software implementation of control algorithms in digital systems. The example of a block diagram of an algorithm for implementing a controller.

62. The principles of a systematic approach in the traditional design.

63. Traditional design methods based on the example of prototype design.

64. The hierarchical structure of project specifications and hierarchical levels of design.

65. The stages of design. The purpose and content of technical design tasks. Typical design procedures.

66. The product life cycle (LC). Stages of the product life cycle.

67. The integrated product information model and its specific models, such as marketing, design, technology, sales and operational.

68. Electronic product model (EPM) as a virtual product. The structure of information about the product and its division into geometric-graphic and non-graphic.

69. The concept of technology information support for the product life cycle, CALS-technology.

70. ISO standards. The STEP standard, the formalised design language Express.

71. The international classification of modern CAD

72. PDM - document management, MRP - supply management.

73. CAD structures.

74. Types of computing systems (CS) used in CAD.

75. CS operating modes.

76. Systems with non-uniform memory access (NUMA).

77. Cluster systems.

78. The performance of parallel computing systems.

79. Reduced Instruction Set Code (RISC) processors.

80. Specialty processors, their role in CAD.

81. The purpose, parameters and classification of arithmetic logic devices.

82. The principles of the operation of control automata with the stored in memory and rigid logic.

83. Interrupt system deployment options.

84. The hierarchical structure of the computer memory.

85. Levels of the cache memory.

86. Random (RAM), varieties, features and operating modes.

87. Drives on magnetic and optical media, parameters, classification and operating modes.

88. Data input/output channels, their functions, parameters, classification, structure and implementation examples.

89. The input-output interface arrangements.

90. Workstation hardware in CAD.

91. Types of computer networks.

92. Access methods of in local computer networks.

93. High-speed corporate, local and global networks.

94. The characteristics and types of data transmission channels.

95. Types of modulation.

96. Error Control Coding.

97. Methods of multiplexing of channels.

98. Network and transport protocol functions.

99. Brief characteristics of network protocols.

100. Functions of network operating systems.

101. 2D geometric models. Wireframe, surface and solid 3D geometric modeling.

102.Presentation of curves by means of spline approximation, Bézier method, B-splines.

103. The analytical and parametric models of surfaces.

104. The compound models of surfaces.

105. The spline models of curves and surfaces.

106. Bezier, Ferguson and Koons models, B-spline, NURBS for curved lines and surfaces.

107. The algorithms and software needed to solve metric and positional problems of geometric modelling.

108. The concept of parametrisation of design items.

109. The main stages and methods of visualisation of images.

110. Geometric transformations, i.e. transfer, scaling and rotation.

111. The canonical apparent volume, species coordinates and projection operation.

112. Vector and raster ways of reproducing the graphic information on graphic devices.

113. Scanning images in the raster technology.

114. Algorithms for constructing lines, cutting off polygons, removing invisible lines and surfaces in raster graphics.

115. Algorithms for line-by-line scanning, area division, depth sorting and Z-buffer application.

116. Basics of colour reproduction with modern graphics devices.

117. Algorithms for illumination by direct and scattered rays, the formation of shadows and photorealistic mapping of fields of various physical nature.

118. Video information compression and encoding problems.

119. JPEG and MPEG standards.

120. Hardware-independent OpenGL graphical interface, the purpose, functions and capabilities.

121. The requirements to mathematical models and numerical methods of analysis in CAD.

122. The examples of mathematical models with distributed parameters.

123. Stationary and non-stationary problems.

124. The method of finite differences, the finite element method, the Bubnov-Galerkin method, the method of boundary elements as a version of the weighted residual method.

125. The formation of computational models based on geometric models of products.

126. Representation of the structure of objects in the form of graphs and equivalent schemes.

127. The analogies of equations and phase variables in mathematical models of various physical nature systems.

128. The examples of component and topological equations in mechanical, electrical, hydraulic and thermal systems.

129. The characteristics of the methods designed to form the mathematical models of systems at the macro level.

130. Choosing methods to analyse static states and transient processes based on analogue models.

131. The eigenvalue problem and Lyapunov stability analysis.

132. Numerical-analytical methods for the study of dynamical systems.

133. Making arrangements for the computational process in the general-purpose analysis programmes at the macro level.

134. Methods of analysis in the frequency domain.

135. Multivariate analysis methods.

136. Set operations. Functions. Equivalence relations. Ordering relationship.

137. Fuzzy sets.

138. Algebraic structures. Morphisms. Algebras with one and two operations.

139. Vector spaces. Boolean functions. Normal forms.

140. Decomposition of Boolean functions. Minimisation of Boolean functions.

141. Logical calculus. Graphs and model graphs.

142. Stability, coverings and matchings. Embedding graphs.

143. The mathematical models of discrete devices.

144. Synchronous and asynchronous models. Methods for detecting the risks of failure in logic circuits.

145. Methods of logical modelling.

146. Making arrangements for the computational process with mixed (analogue-digital) modelling.

147. Analytical models of queuing systems (QMS).

148. QMS simulation modelling.

149. Random variable simulation.

150. Simulation experiment results processing.

151. The event method of modelling.

152. Varieties of Petri nets. An analysis of Petri nets.

153. Cao Yong neural networks and their use.

154. The structural and parametric synthesis. Optimality criteria.

155. One-dimensional optimisation methods. Gradient methods. Direct search methods.

156. Methods of searching for conditional extremums. Methods of penalty functions.

157. The tasks of the traveling salesman.

158. Vehicle routing issues.

159. Schedule synthesis issues.

160. The method of branches and boundaries.

161. The methods of local optimisation and search with prohibitions.

162. The computational scheme of the dynamic programming method.

163. Evolutionary strategies. Genetic algorithms.

164. The examples of solving logistical problems with genetic algorithms.

165. Task setting and algorithms for the f equipment layout and placement and wiring routing.

166. Topological synthesis methods.

167. Parallel algorithms. Synchronisation of concurrently running processes.

168. Parallel algorithms for solving the systems of algebraic equations.

169. Parallel algorithms for solving the Cauchy problem for ordinary differential equations. Parallel algorithms for non-linear programming.

170. Programming languages of artificial intelligence and knowledge representation languages.

171. The concept of open systems, DCOM, CORBA.

172. Tools for the conceptual design of automated systems.

173. Types of CASE-systems.

174. IDEFO, IDEF3 and EDEF1X methods.

175. Unified modelling language UML, methods of designing object-oriented systems based on UML.

176. Pattern recognition techniques.

177. Expert system architecture. Organisation of databases and knowledge in automated systems.

178. Information models of design objects and the vocabulary of the problem domain, a library of basic elements.

179. Knowledge representation, frames, semantic networks and product rules.

180. Basic concepts of the fuzzy and continuous logic.

181. Intelligent data analysis, DM and OLAP technologies.

182. Database management systems (DBMS), the fields of application, structure, composition and characteristics.

183. Data banks (DB). Data bank requirements. Hierarchical, network, relational, multidimensional, object-oriented and object-relational models.

184. Database design stages, the conceptual, logical and physical design.

185. Data access arrangements, linear search, arbitrary organisation, index-sequential access method, B-trees and secondary access methods

186. Query languages, the relational algebra, relational calculus, SQL and QBE.

187. Distributed information systems. Data fragmentation and distribution methods.

188. Mathematical programming. Minimax (game) statement of the linear programming problem. The tasks of production planning and its alternative task.

189. Model, algorithm, programme, numerical experiment. A computational experiment. Principles of carrying out a computing experiment.

190. The market for forward and futures contracts. Hedging risk and speculation (playing with the exchange rate difference) using futures contracts. The Black-Scholes Option Pricing Model (OPM) determining the price of a standard option.

191. Simulation modelling in the economy. Verification of and checking the adequacy of the simulation model. The examples of simulation in business.

192. Investments and economic growth. Economic essence and types of investments.

193. Evaluation of the effectiveness of investment projects. The social and economic efficiency of production.

194. The main means of an entity, the economic content, composition and structure and efficiency of use.

195. The working capital of an entity, the economic content, composition and structure, management of circulating assets and efficiency of use.

196. Inflation and the types, factors, management. The anti-inflationary policy of the state.

197. Management structure: classification of management functions, delegation and leadership style.

198. The modern banking system in Russia.

199. Finances and the financial system. The financial policy and state budget of Russia.

200. The taxation system of the Russian Federation.

201. Forecasting, planning and management at the level of an economic entity.

202. Business plan. The sections and content of a business plan. Financial plan.

203. Managerial analysis as a tool for modern management.

204. Concepts of the system approach, a system analysis.

205. Models of systems, such as static, dynamic, conceptual and topological, formalised (the formalisation procedures for system models), information, logical-linguistic, semantic and set-theoretic.

206. The optimisation approach to management and decision-making problems.

207. Basic approaches to solving problems with constraints.

208. Definition and general classification of information technology types.

209. The logical and physical organisation of databases.

210. Methods for designing relational databases (normalization, semantic data modelling, ER-diagrams).

211. Languages and tools for programming Internet applications.

212. The main sections of the theory and applications of artificial intelligence.

213. The purpose and principles of building expert systems.

214. Elements of the theory of functions and functional analysis.

215. Mathematical programming, its classification.

216. Convex programming and solution methods.

217. Linear programming. Simplex method.

218. The principle of dynamic programming.

219. Problems of optimal control.

220. Probability, conditional probability. Elements of the theory of random processes.

221. The Monte Carlo method.

222. Simulation modelling.

223. Multi-agent systems.

224. Situational management.

225. Client-server technology.

226. Designing. Design and process design. Computer-aided design.

227. Definition of CAD; Examples of CAD.

228. Classification of CAD. Key functions of CAD/CAM/CAE systems.

229. Geometric modelling. Types of geometric models of 3D objects.

230. The concept of parametrisation in geometric modelling.

231. The structure and types of CAD support.

232. The information support for CAD; Automated database, databases, database management systems, languages for describing and manipulating data.

233. Linguistic support to CAD; the classification of CAD languages and the principles of their creation; Interpreters and compilers; Programming languages: purpose, classification and development trends.

234. The technical support to CAD and its features.

235. Vector and raster images. Graphic data formats. Examples.

236. Problems of mathematical and linear programming. Geometric method for solving the linear programming problem.

237. Discrete optimisation algorithms. Precise and approximate algorithms.

238. Analysis of the complexity and effectiveness of algorithms, NP-complex and difficult to solve problems.

239. Estimates of the complexity of algorithms on the example of problems in computational geometry

240. Definition of the operating system (OS). OS classification.

241. Basic principles of OS construction. Process and memory management in the OS. I/O device management, the physical organisation of input-output devices, the input-output software organisation and device drivers.

242. File system (FS): definition of FS, file names, file types, logical organisation of files, physical organisation of files, file access rights and file system architectures.

243. Programming languages. Problem-oriented languages. Translators. Types of translators.

244. Basic concepts of computational geometry; Homogeneous coordinates, matrix transformations; the rational parametric curves and surfaces; the Bézier method

245. Processing of graphic information in CAD. Vector and raster images. Elements and attributes of the image. A comparison of vector and raster images.

246. The colour of raster images. Black-and-white image and image ’in grayscale’. Colour depth.

247. The colour models. RGB and CMYK models. Their components.

248. The colour coverage. HSB and L * a * b models. Their components.

249. The classes of images. The algorithm comparison criteria. Image quality. Lossless compression. RLE, LZW, JBIG algorithms.

250. The concept of the alphabet. Coding. Alphabet coding. The Huffman algorithm.

251. Lossy compression algorithms. The JPEG algorithm.

252. Fractal images. Classification of fractals.

253. A general mathematical description of fractal images. IFS Geometric fractals. Examples. Algebraic fractals. The Mandelbrot set.

254. Protection Mechanisms for software products CAD.

255. Optimisation problems and algorithms in CAD. Discrete optimisation. P and NP classes. The examples of optimisation tasks in CAD.

256. Rapid prototyping. Stereolithography. Massive stereolithography (Solid Groud Curing).

257. The layer deposition of the molten polymer FDM. Jet spraying of polymer. 3D printers. LOM - technology.

258. RP-technology. STL-format. Layer sintering of the material. Areas of use

259. Communication of CAD with other information systems. ERP system. PDM system. CALS technology. The main components of CALS-technologies.