BULGARIAN ACADEMY OF SCIENCES
INSTITUTE OF MATHEMATICS AND INFORMATICS

QUESTIONNAIRE

for the PhD entrance examination for the doctoral program "Informatics", effective from 2025

1. Information. Information processes and activities. Informatics and information services. Information society – essence and definitions. [28] [29] [31]
2. Mathematical logic. Propositions and predicates. Boolean algebra. [4] [27] [32]
3. Algorithms – definitions and properties. Computability, complexity, and optimality. Turing machines. Undecidable algorithmic problems. Church–Turing thesis. [4] [32]
4. Formal languages and generative grammars – definition, types, properties, examples. Chomsky hierarchy. [4] [32]
5. Primitive and composite data types. Data structures – types, usage, representations. [9] [21] [25]
6. Graphs and trees – definition, basic concepts, types, representations, and fundamental algorithms. [25] [27] [32] [33]
7. Programming languages – classification, syntax, and semantics. Main paradigms in modern programming and their implementation. [18] [21]
8. Databases. Data models – types, characteristics, and comparison. Database management systems. [13] [14] [16]
9. Big Data – essence and main characteristics. CAP theorem. Main types of NoSQL databases. Principles of the MapReduce technology. [14] [15] [16]
10. Machine learning and knowledge discovery. The process of Knowledge discovery from data. CRISP-DM – main stages and outcomes. [6] [8]
11. Machine learning methods – main types, characteristics, and applications. Presentation of the working principle of a specific machine learning algorithm. [10] [26]
12. Software product lifecycle. Software development approaches. Software process models. [2] [30]
13. Digital libraries – types and main functions. Applications in the field of cultural heritage. Standards and metadata. [5] [12] [19] [20]
14. Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) – main characteristics, functionality, advantages and disadvantages, applications. [34]
15. Cloud technologies – essence, defining characteristics. Types of services – SaaS, PaaS, etc. Deployment models (private, community, public, and hybrid cloud). [11] [17]
16. Types of malware: characteristics, goals, distribution vectors, infection methods; protection methods. [3] [23]
17. Methods and techniques used to protect information systems from malware and attacks: network segmentation; traffic filtering and use of firewalls; antivirus software and security-related software; intrusion detection and prevention systems (IDS/IPS); access control and authentication. [1] [7] [22] [24]

Sample bibliography

1. Al-Ateeq I: Design Secure Network Segmentation Approach, SANS Institute 2021
2. Ashmore S., Kr. Runyan: Introduction to Agile Methods, Addison-Wesley Professional, 2014.
3. Aycock J.: Computer Viruses and Malware. Springer, New York, 2006.
4. Biggs, N.: Discrete Mathematics. Oxford University Press, 2002.
5. Candela L. et al., The DELOS Digital Library Reference Model: Foundations for Digital Libraries, 2007.
6. Chapman P., J. Clinton, R. Kerber, Th. Khabaza, Th. Reinartz, C. Shearer, and R. Wirth, CRISP-DM 1.0 Step-by-step data mining guides. 2000.
7. Coulibaly K.: An Overview of Intrusion Detection and Prevention Systems, arXiv preprint, 2020. Available: https://arxiv.org/abs/2004.08967.
8. Fayyad U., G. Piatetsky-Shapiro, P. Smyth: From data mining to knowledge discovery: an overview. In Advances in Knowledge Discovery and Data Mining. American Association for AI, Menlo Park, CA, USA, 1996, pp.1-34.
9. Goodrich, M.T., Tamassia, R., Goldwasser, M.H.: Data Structures and Algorithms, 6th Ed, Wiley, 2014.
10. Han, J., Kamber, M., Pei, J.: Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, 3rd ed., 2011.
11. Homer A. et al.: Cloud Design Patterns: prescriptive architecture guidance for cloud applications. Microsoft, 2014.
12. Ivanova, K., Dobreva, M., Stanchev, P., Totkov, G. (editors): Access to Digital Cultural Heritage: Innovative Applications of Automated Metadata Generation. University Publishing House "Paisii Hilendarski", Plovdiv, 2012, http://www.math.bas.bg/infres/book-ADCH/index.htm
13. Kroenke, D.M., Auer D.J., Vandenberg, S., Yoder R.: Database Concepts. 8th ed., Pearson, 2018.
14. Lemahieu W., S. Broucke, B. Baesens: Principles of Database Management: The Practical Guide to Storing, Managing and Analyzing Big and Small Data, Cambridge University Press, 2018.
15. MapReduce Tutorial. Apache Hadoop. https://hadoop.apache.org/docs/r1.2.1/mapred_tutorial.html
16. Meier, A., Kaufmann, M.: SQL & NoSQL Databases: Models, Languages, Consistency Options and Architectures for Big Data Management, Springer Vieweg, 2019.
17. Microsoft: Cloud Design Patterns. https://www.microsoft.com/en-us/download/confirmation.aspx?id=42026
18. Nakov, S.: Programming Basics with C#. 2018, https://csharp-book.softuni.org/
19. Nisheva-Pavlova M., D. Shukerov, P. Pavlov: Building a Social Semantic Digital Library. ElPub, 2015.
20. Paneva-Marinova, D., Goynov, M., Luchev, D.. Multimedia Digital Library: Constructive Block in Ecosystems for Digital Cultural Assets. Basic Functionality and Services. LAP Lambert Academic Publishing, 2017, ISBN:978-3-659-87899-2, 132 p.
21. Scott M.L.: Programming language pragmatics, 4th Ed, Morgan Kaufmann, 2015.
22. Stallings W., L. Brown: Computer Security: Principles and Practice, 4th ed., Pearson, Boston, MA, 2018.
23. Szor P.: The Art of Computer Virus Research and Defense. Addison-Wesley Professional, Boston, MA, 2005.

24. W. Stallings, Network Security Essentials: Applications and Standards, 6th ed., Pearson, Boston, MA, 2016.
25. Weiss M.A.: Data structures & algorithm analysis in C++, 4th Ed, Pearson, 2013.
26. Witten, I.H., Frank, E., Hall, M.A., Pal, C.J.: Data Mining – Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 4th edition, 2016.
27. Бойчева, С., Толева-Стоименова, С.: Дискретна математика. Сиела, София, 2018.
28. Бърнев, П.: Информация и управление, С. Народна просвета, 1978.
29. Денчев Ст.: Информационните технологии и предизвикателствата пред нацията. Годишник на секция "Информатика", СУБ, том 1, 2008, стр. 3-12. http://old.usb-bg.org/Bg/Annual_Informatics/2008/SUB-Informatics-2008-1-003-012.pdf
30. Ескенази А., Н. Манева: Софтуерни технологии, КЛМН, 2 изд., 2006.
31. Ешби У. Р.: Въведение в кибернетиката. Наука и изкуство, София, 1967.
32. Манев, К.: Увод в дискретната математика. Издателство на НБУ, София, 2 изд., 1998.
33. Манев, Кр.: Алгоритми в графи. КЛМН, 2022.
34. Попов В.: Системи за управление на учебното съдържание: анализ, сравнение, тенденции. Конф. "Висшето образование и бизнесът в контекста на Стратегия Европа 2020", 2014, https://www.researchgate.net/publication/312117062_Sistemi_za_upravlenie_na_ucebnoto_sdrzanie_analiz_sravnenie_tendencii