

Syllabus on the course “Cloud Computing”
Approved by Programme Academic Council
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Credits	3
Academic Hours	114
Year of study	1
Mode of study	Full-time

1. Prerequisites:

- Basic computer science principles and skills
- Basic knowledge of Internet technologies and Web applications

2. Course Type

Cloud computing is an elective course for first year master students enrolled on the program “Big Data Systems”.

3. Abstract

Cloud Computing is a technology that allows to use the resources of large number of computers connected through a real-time communication network. By using cloud computing, you can gain access at any time through any device, via the Internet, to data and files which you have uploaded, or to software applications which you need to use for personal or professional use. Cloud computing being used more and more in business today and it is very important for any professional to understand what it is all about.

This course defines Cloud Computing and establishes a strong working knowledge of the concepts and technologies needed to work effectively with the cloud. The course allows to understand what cloud computing is and how it works. It describes the benefits of cloud computing along with its potential drawbacks. The course enables to determine which cloud is appropriate from a business and technical perspective, to select appropriate cloud providers and to plan and implement a cloud adoption strategy. Formation of the theoretical knowledge and practical skills in practical realization of the benefits of cloud computing in today's business, learning the tools of the technology. The course covers technologies required to build classic (traditional), virtualized, and cloud data center environments. These technologies include compute, storage, networking, desktop and application virtualization.

4. Learning Objectives

- introduction to the basic concepts and terminology of cloud computing;
- familiarization with areas of cloud technologies;
- acquaintance with the concept of cloud computing in relation to business activities;

- evaluate the efficiency of, long-term perspective, the study of economics of cloud computing;
- feasibility study to migrate existing applications to a cloud environment from both a technical and an economic point of view;
- introduction of cloud computing infrastructure;
- Security Studies, scaling, deployment, backup, in the context of cloud infrastructure;
- learning techniques cloud programming;
- development of system administration skills for the development and maintenance of applications deployed in the cloud

This program of an academic discipline establishes minimum requirements for knowledge and skills of the student and determines the content and types of studies and reports.

5. Learning Outcomes

While mastering the course material, the student will

Know:

- - the basic concepts and terminology of cloud computing;
- - the application of cloud computing;
- - the concept of cloud computing in relation to business activities;
- - the basic principles of cloud computing and methods for developing applications for the cloud using a variety of platforms;
- - cloud computing infrastructure;
- - security, scalability, deployment, backup, in the context of cloud infrastructure;

Be able to:

- - use techniques of cloud programming
- - make an assessment of efficiency of application, long-term prospects, study of economics of cloud computing;

Have skills:

- - software development cloud,
- - system administration for the development and maintenance of applications deployed in the cloud

Main provisions of the discipline should be used further to prepare master theses, scientific articles and reports.

6. Course Plan

Theme 1. The history of the main types of high-performance computing, the development trend of modern infrastructure solutions.

Introduction to the main stages in the development of computer technology. The main stages in the development of hardware and software. Analysis of current trends in hardware, leading to the emergence of cloud computing technologies. Basic information about the appearance, development and use of cloud computing technologies. A Cloud as a type of parallel and distributed system.

The main current trends of hardware, basic infrastructure requirements. Examines the current trends in the development of infrastructure solutions that have led to the concept of cloud computing.

Growth performance computers. The advent of multi-processor and multi-core computing systems, the development of blade systems. The emergence of systems and storage area networks. Infrastructure Consolidation.

Theme 2. Introduction to the concept of cloud computing. Advantages and disadvantages of cloud computing.

Overview of cloud computing paradigm, cloud architecture. Major Goals of Cloud Computing. Brief History of Cloud Computing. Model deployment of clouds: private cloud, public cloud, hybrid cloud, public cloud. Basic service delivery models of cloud computing: Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a service (IaaS), other cloud services (XaaS). Cloud Applications. Cloud Computing and Grid Computing: A Comparative Study.

The main advantages and disadvantages of cloud computing models and the suggested solutions based on them. Economics of cloud computing. OpEx (Operational expenditure) and Capex (Capital Expenditures) in IT-industry.

Theme 3. Review of existing services and models of cloud computing. Review of existing platforms.

Companies involved in Cloud Computing. Review of decisions leading vendors - Microsoft, Amazon, Google. Examples of cloud services Microsoft. Development and testing of applications on Microsoft Azure Cloud. Development and testing of applications on Amazon Elastic Computing Cloud. Examples of cloud services Google. Review of other cloud vendors. Ratings: financial, security, technical, licensing.

Theme 4. Cloud computing technology. Major Components to Cloud Computing.

Cloud Computing Technologies. Architecture Requirements. Major Components to Cloud Computing: applications, clients, infrastructure, platform, service, storage. Programming techniques,

skills, system administration applications deployed in the cloud. Construction of transactional Web-based applications, the installation of virtual servers to support them. Security issues, scaling, deployment, backup, in the context of the cloud infrastructure. The advantages of cloud infrastructure in scaling applications.

Theme 5. The virtualization techniques and services. The main directions of their development.

The virtualization technology and its theoretical foundations. Types of Virtualization: full virtualization, para virtualization, operating system virtualization (container virtualization). Compute virtualization overview: Virtual Machines, Resource management techniques, Physical to virtual conversion. Level virtualization of computing. Level virtualization storage. Virtualization at the network level. Workstation applications virtualization level.

Theme 6. Cloud computing technologies: NoSQL databases, MapReduce.

Relational and NoSQL databases – is a clash of cultures (ACID vs BASE). Introduction to NoSQL databases. CAP theorem. NoSQL database types: key-value stores, column stores, document databases, graph stores. Cloud development platform MapReduce, development cloud platform Apache Hadoop. Open standards to provide cloud services. Terms and Conditions.

Theme 7. Cloud Reference Architecture. Migration from Standard Environment to Cloud Computing.

Cloud Reference Architecture: cloud consumer, cloud provider, cloud carrier, cloud auditor and cloud broker. The interaction between cloud actors. Migration Considerations. Phases of migration to Cloud. Selecting the appropriate deployment model in line with the existing business objectives. Select applications to public clouds. Development of Web-based applications for deployment in the cloud, moving to her existing applications. Choosing a suitable provider of cloud services. The concept of SLA. SLA metrics for IaaS, PaaS, SaaS. Phase introduction of cloud infrastructure in the enterprise.

7. Reading List

Required

1. Cloud computing: concepts, technology & architecture / T. Erl, Z. Mahmood, R. Puttini. – Upper Saddle River [etc.]: Prentice Hall, 2015. – 489 c. - ISBN 978-0-13-338752-0.
2. Cloud computing / N. B. Ruparelia. – Cambridge; London: The MIT Press, 2016. – 260 c. – (The MIT Press essential knowledge series) - ISBN 9780262529099.

3. Cloud computing for science and engineering / I. Foster, D. B. Gannon. – Cambridge; London: The MIT Press, 2017. – 372 c. – (Scientific and engineering computation) - ISBN 9780262037242.
4. Data analysis in the cloud: models, techniques and applications / D. Talia, P. Trunfio, F. Marozzo. – Amsterdam [etc.]: Elsevier, 2016. – 138 c. – (Computer science: reviews and trends) - ISBN 978-0-12-802881-0.
5. Developing and securing the cloud / B. Thuraisingham. – Boca Raton; London; New York: CRC Press, 2014. – 700 c. - ISBN 978-1-439-86291-9.
6. Cloud computing: data-intensive computing and scheduling / F. Magoules, J. Pan, F. Teng. – Boca Raton [etc.]: CRC Press: Taylor & Francis Group, 2013. – 205 c. – (Chapman & Hall/CRC numerical analysis and scientific computing) - ISBN 978-1-466-50782-1.
7. Rhoton, J.: Cloud computing explained / J. Rhoton. – [London]: Recursive Press, 2013. – 447 c. - ISBN 978-0-9563556-0-7.
8. Cloud enterprise architecture / P. Raj. – Boca Raton [etc.]: CRC Press: Taylor & Francis Group, 2013. – 489 c. - ISBN 978-1-466-50232-1.
9. Cloud computing and services science / Ed. I. Ivanov, M. Sinderen van, B. Shishkov. – New York [etc.]: Springer, 2012. – 390 c. – (Service science: research and innovations in the service economy) . - ISBN 978-1-461-42325-6.
10. Politics and the Internet in comparative context: views from the cloud / Ed. by P. G. Nixon, R. Rawal, D. Mercea. – London; New York: Routledge, 2013. – 255 c. – (Routledge research in political communication; 11) . - ISBN 978-0-415-63867-8.
11. Business in the cloud: what every business needs to know about cloud computing / M. Hugos, D. Hulitzky. – Hoboken: John Wiley & Sons, 2011. – 205 c. – На англ. яз. - ISBN 978-0-470-61623-9.
12. Cloud security and privacy / T. Mather, S. Kumaraswamy, S. Latif. – Beijing [etc.]: O'Reilly, 2009. – 312 c. - ISBN 978-0-596-80276-9.

Optional

1. NoSQL: новая методология разработки нереляционных баз данных / П. Дж. Садаладж, М. Фаулер; Пер. с англ. и ред. Д. А. Ключина. – М.; СПб.; Киев: Вильямс, 2016. – 183 c. - ISBN 978-5-84591-920-5.
2. NoSQL: database for storage and retrieval of data in cloud / Ed. by G. C. DeKa. – Boca Raton [etc.]: CRC Press: Taylor & Francis Group, 2017. – 455 c. , ISBN 9781498784368.
3. Storing and managing big data NoSQL, Hadoop and more: high-impact strategies- what you need to know: definitions, adoptions, impact, benefits, maturity, vendors / K. Roebuck. – Samford: Tebbo, 2011. – 228 c. , ISBN 978-1-7430-4574-9.

4. Введение в облачные вычисления <https://www.intuit.ru/studies/courses/673/529/info>
5. Технологии облачных вычислений <https://www.intuit.ru/studies/courses/3508/750/info>
6. Облачные технологии управления малым и средним бизнесом
<https://www.intuit.ru/studies/courses/3528/770/info>

8. Grading System

Procedure for the formation of estimates on discipline

Generating estimates of the discipline is made in accordance with the Regulations on the organization of the control of knowledge, approved by the Academic Council of the HSE.

Evaluation Criteria

Assessment compliance table – ten-point rating to 5-point rating

Ten-point scale	Five-point scale
1 – unsatisfactory 2 - very bad	unsatisfactory - 2
4 - satisfactory 5 – very satisfactory	satisfactory - 3
6 - well 7 – very well	Well – 4
8 - almost perfect 9 - perfect	excellent - 5

A grade of 4 or higher means successful completion of the course ("pass"), while grade of 3 or lower means unsuccessful result ("fail"). Conversion of the concluding rounded grade **O(Total)** (is showed in section *Calculation of the grade*) to five-point scale grade.

Calculation of the grade

Current and resultant grades are made up of the following components:

- work in seminars and workshops (problem solving using computers, reports, discussion) (**SW**);
- homework and tests (**HW**);
- Essay (**ES**);
- abstract (**AB**);
- taking tests (**TT**)

Finally, the total course grade on ten-point scale is obtained as

$$\mathbf{O(Total) = 0,15 * O(SW) + 0,25 * O(PW) + 0,1 * O(ES) + 0,2 * O(AB) + 0,3 * O(TT).}$$

A grade of 4 or higher means successful completion of the course ("pass"), while grade of 3 or lower means unsuccessful result ("fail"). Conversion of the concluding rounded grade **O(Total)** to five-point scale grade by arithmetic rounding.

9. Guidelines for Knowledge Assessment

Forms and Types of Testing

Type of control	Form of control	1 year				Department	Parameters
		1	2	3	4		
Current (week)	Essay			week 8		Base department of Stack Group Company	1-2 thousand words
	Abstract				week 7		Electronic report 10-15 pages plus presentation (15 slides), oral protection
Resultant	taking tests				week 9		written test (paper) in form answers on control questions

The examples of abstract topics:

1. Overview of the main cloud providers: trends and new providers.
2. Tendencies in cloud computing: new directions, unsolved and forward-looking issues.
3. Influence of legislation of different countries on the spread of cloud technologies.
4. Application of cloud technologies in public administration (by the example of any country)
5. Application of cloud technologies in urban management
6. Cloud application in bioinformatics and healthcare.
7. Cloud computing: Full-text search in clouds
8. Personal Data Protection in Cloud
9. Web 2.0 technologies - is it a marketing trick or a set of technologies that lead to cloud computing?
10. Overview of virtual machine technologies used by different cloud providers.
11. LXC and Docker technologies in cloud computing.
12. Advantages and disadvantages of NoSQL in comparison with relational databases
13. Comparative review of different types of NoSQL (Key-value vs Column vs Document vs Graph).

14. Comparative review of the Key-value NoSQL: CouchDB, Dynamo, Redis, Riak, Aerospike, OrientDB.
15. Comparative review of Column NoSQL: Accumulo, Cassandra, Druid, HBase, Vertica
16. Comparative review of Document NoSQL: Clusterpoint, Apache CouchDB, Couchbase, MarkLogic, MongoDB
17. Comparative review of Graph NoSQL: Allegro, Neo4J, InfiniteGraph, OrientDB, Virtuoso

Final exam topics

1. How many generations of computers describes the story?
2. Major Goals of Cloud Computing.
3. Brief History of Cloud Computing.
4. NIST Cloud Definition.
5. Cloud service models definitions: IaaS, PaaS, SaaS; XaaS.
6. Model deployment of clouds: private cloud, public cloud, hybrid cloud, public cloud.
7. What are the main benefits of cloud computing.
8. What are the main disadvantages of cloud computing.
9. Major Components to Cloud Computing: applications, clients, infrastructure, platform, service, storage.
10. Security issues, scaling, deployment, backup, in the context of the cloud infrastructure.
11. What are the main benefits of storage systems.
12. What types of clouds are there?
13. That provide service providers IaaS?
14. What is hidden under the acronym PaaS?
15. What is hidden under the acronym SaaS?
16. Note the main advantages of SaaS for customers.
17. The main purpose XaaS.
18. The examples of Cloud Applications.
19. Cloud Computing and Grid Computing: A Comparative Study.
20. Cloud Computing and HPC: A Comparative Study.
21. Open Standards. Terms and Conditions of cloud computing.
22. Review of base cloud vendors.
23. The main advantages of using Windows Azure.
24. What is the components of the cloud Microsoft?
25. The main advantages of using Amazon Web Services.

26. Note the main features of Google Apps.
27. Security issues, scaling, deployment, backup, in the context of the cloud infrastructure.
28. Compute virtualization overview.
29. What are the main benefits of virtualization.
30. Specify the main varieties of virtualization.
31. What are the main virtualization platforms.
32. Level virtualization of computing.
33. Level virtualization storage.
34. Virtualization at the network level.
35. Workstation applications virtualization level.
36. Relational and NoSQL databases – is a clash of cultures (ACID vs BASE).
37. CAP theorem.
38. NoSQL database types: key-value stores, column stores, document databases, graph stores.
39. Cloud development platform MapReduce.
40. Open standards to provide cloud services. Terms and Conditions.
41. The base actors of clouds and interaction between them.
42. Migration Considerations, phases of migration to Cloud.
43. Selecting the appropriate deployment model in line with the existing business objectives.
44. Selecting applications to public clouds.
45. Choosing a suitable provider of cloud services. The concept of SLA.

10. Special Equipment and Software Support

Personal computer (laptop) and a projector are used for lectures and seminars. Technical equipment of computer classes may be used too.