COURSE OUTLINE

(1) GENERAL

SCHOOL	School of Engineering		
ACADEMIC UNIT	Informatics and Computer Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE		**SEMESTER**	8th
COURSE TITLE	Cloud Computing and Services		
INDEPENDENT TEACHING ACTIVITIES if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits		**WEEKLY TEACHING HOURS**	**CREDITS**
		4	5
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).			
COURSE TYPE general background, special background, specialised general knowledge, skills development	Specialised general knowledge, skills development		
PREREQUISITE COURSES:	Operating Systems I & II, Distributed Systems		
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek		
IS THE COURSE OFFERED TO ERASMUS STUDENTS			
COURSE WEBSITE (URL)	https://eclass.uniwa.gr/courses/ICE326/		

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.
Consult Appendix A

- Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area
- Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B
- Guidelines for writing Learning Outcomes

The course aims to present and argue on: the basic concepts and important capabilities of cloud computing, the understanding of support technologies and required infrastructures, the analysis of individual systems and techniques, the deepening of application planning and development technologies, the demonstration of the most important services offered, and in applying all of the above to areas of real-world problems and further research.
Upon successful completion of this course each student will be able to:

- Realize the cloud computing paradigm basic characteristics and capabilities, the technologies on which the Clouds rely on, which are the delivery and service models, etc.
- Understand and comprehend topics on virtualization and virtual machines (VMs), how the VMs communicate with the operating systems (OS), how cloud computing utilizes VMs, how VNs integrate into clusters and datacenters
- Investigate and apply modern techniques and methodologies for analyzing and designing cloud-based systems and infrastructures
- Deepen in cloud-based applications architecture, systems, and service provisioning, as well as in the Cloud mechanisms regarding its distributed management, load balancing, and high availability
- Understand and comprehend about middleware/development platforms (cloud platforms and OS) and they are utilized to construct fine-grained solutions on the Cloud
- Evaluate and design fine-grained solutions on integrating a business computing and application infrastructure on the Cloud
- Utilize offered programming techniques, libraries, interfaces and toolkits to develop

applications/services and scientific calculations on the Cloud
- Scrutinize and to utilize cloud-based applications and services which are offered by various vendors
- Analyze advance concepts of cloud computing, such as: capacity planning, workloads distribution, resource provisioning, load balancing, elasticity, high availability, cloudonomics, etc.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	Project planning and management Respect for difference and multiculturalism Respect for the natural environment
Adapting to new situations	Showing social, professional and ethical responsibility and sensitivity to gender issues
Decision-making	Criticism and self-criticism
Working independently	Production of free, creative and inductive thinking
Team work	……
Working in an international environment	Others…
Working in an interdisciplinary environment	…….
Production of new research ideas	

- Search for, analysis and synthesis of data and information, using the necessary technologies
- Working independently
- Teamwork
- Adapting to new situations
- Working in an interdisciplinary environment
- Production of new research ideas
- Advance of free, creative and inductive thinking

(3) SYLLABUS

A. Introduction on Cloud Computing: Terminology, basic characteristics, technologies, capabilities of developers and end-users. The NIST model. The cloud cube model. Delivery and Service models. Concepts of IaaS, PaaS and SaaS. Concepts of private, public, community και hybrid Clouds.
B. Virtual Machines – Clusters – Data Centers: The virtualization and virtual machines concepts (virtual machines – virtualization, virtualization types, the hypervisor concept, containers, etc.), how are they utilized and what is their importance when developing applications on the Cloud. Physical and virtual clusters. Provisioning and organization requirements, datacenter integration and management, and toolkits (e.g. VMware, Xen, KVM, Docker)
C. Middleware software / Development platforms: What are the middleware software and their respective toolkits / cloud platforms and what is their importance in developing cloud services; interfaces with lower levels (e.g. virtual machines), their offered capabilities, and their interaction with offered services (e.g. Amazon Web Services – AWS); Known implementations and case-studies (e.g. Nimbus, Eucalyptus, OpenNebula, CloudStack, OpenStack, etc.)
D. Architectures – Design Concepts: Reference Architecture (cloud reference model), capacity planning, resource provisioning, auditing & monitoring. Workloads distribution, Load balancing, Resource pooling, Load testing and resource ceilings, Dynamic scalability, Elasticity. Cloud serverless architecture. Cloud computing & IoT (fog computing), etc.
E. Programming technologies – Applications on scientific calculations development: Offered technologies and libraries, integration of interactive application and hyper-performance computing. Review on scripting languages, development tools, APIs - web services, the microservices paradigm, etc.). Distributed file systems, Big Data management. Case-studies and practice on GAE/Google APIs and Hadoop/MapReduce, Spark.
F. Cloud Applications/Services for the end-user: Hosting, office automation and collaboration, web and mobile applications development, Big Data processing and analytics, CRM, ERP, E-Commerce, Data center services, etc. Review on major vendors (Google, Microsoft, Amazon, IBM, etc.) and their offered services suite.
G. Other Issues. Requirements on cloud security and high availability. Cloud computing

economics (cloudonomics). Moving an enterprise to the cloud – (the 6 R's), Cost Metrics / Pricing Models, Service Quality Metrics / SLAs, Regulatory and Law Topics. Research path – open issues.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY Face-to-face, Distance learning, etc.	Face-to-face. Use of distance learning (if required)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY Use of ICT in teaching, laboratory education, communication with students	Use of ICT in Course Teaching and Laboratory Education, Use of ICT in Communication with Students Post course material on the University's e-learning platform (e-class). Use of email and e-class in communication with students.
TEACHING METHODS The manner and methods of teaching are described in detail. Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc. The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS	<table><tr><th>Activity</th><th>Semester workload</th></tr><tr><td>Lectures</td><td>26</td></tr><tr><td>Tutorials</td><td>13</td></tr><tr><td>Labs</td><td>13</td></tr><tr><td>Project</td><td>38</td></tr><tr><td>Independent Study</td><td>35</td></tr><tr><td>Course total</td><td>125</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>
STUDENT PERFORMANCE EVALUATION Description of the evaluation procedure Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other Specifically-defined evaluation criteria are given, and if and where they are accessible to students.	FINAL GRADE = (50% * Lecture_part + 50% * Lab_part) I. Assessment on the Lecture_part consists of written exams at the end of the semester *** a portion of 30% on the Lecture_part may be assessed by a research project (on-a-students-demand basis) II. Assessment on the Lab_part consists of lab assignments and projects The evaluation process is disclosed to the students in class and online, via e-class.

(5) ATTACHED BIBLIOGRAPHY

1. Thomas Erl, Ricardo Puttini, Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.
2. Dan C. Marinescu, Cloud Computing: Theory and Practice, Morgan Kaufmann, 2013.
3. Kris Jamsa, Cloud Computing, Jones & Bartlett Learning, 2012.
4. Barrie Sosinsky, Cloud Computing Bible, Wiley, 2011.
5. Kai Hwang, Jack Dongarra, and Geoffrey Fox, Distributed and Cloud Computing, Morgan Kaufmann, 2011.
6. Amin Naserpour, R J Cope, and Thomas Erl, Cloud Computing Design Patterns, Prentice Hall, 2015.
7. Michael Kavis, Architecting the Cloud: Design Decisions for Cloud Computing Service Models,

Wiley, 2014.
8. San Murugesan and Irena Bojanova (editors), Encyclopedia of Cloud Computing, Wiley, 2016.
9. Ray Rafaels, Cloud Computing: From Beginning to End, CreateSpace Independent Publishing Platform, 2015.
10. Michael Hugos and Derek Hulitzky, Business in the Cloud: What Every Business Needs to Know About Cloud Computing, Wiley, 2010.
11. Robert Elsenpeter, Anthony Velte and Toby Velte, Cloud Computing: A Practical Appoach, McGraw-Hill, 2010.
12. Borko Furht and Armando Escalante, Handbook of Cloud Computing, Springer, 2010.
13. David Sarna, Implementing and Developing Cloud Computing Applications, Auerbach Publications, 2010.
14. Jure Leskovec, Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.
15. Jimmy Lin, Chris Dyer and Graeme Hirst, Data-Intensive Text Processing with MapReduce, Morgan and Claypool Publishers, 2010.