COURSE OUTLINE

1. GENERAL

SCHOOL	Engineering		
DEPARTMENT	Electrical and Electronics Engineering		
LEVEL OF STUDIES	Undergraduate		
COURSE CODE	**EEE.9-2.4**	**SEMESTER**	9th
COURSE TITLE	Cloud Computing		

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**
Lectures	4	5
Total	4	
Add rows if needed. The teaching organization and teaching methods used are described in detail in 4.		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	In-depth Discipline Mastery Course (IDMC)
PREREQUISITE COURSES:	No
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek
IS THE COURSE OFFERED TO ERASMUS STUDENTS	Yes
COURSE WEBSITE (URL)	https://eee.uniwa.gr/el/spoudes/pps/ps

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 of Cloud Computing aims to give students the necessary knowledge on how to operate the modern cloud computing infrastructure. The course covers theoretical and practical issues related to how physical computing systems can be managed as an entity to serve different types of services. The integration of the physical machines that make up the data centers is based on the concept of virtualization, which will be thoroughly analyzed in this course. Using virtualization technology, cloud computing creates a microcosm inside data centers that simulates the operation of the real world as network structures, security structures, and virtual machines are created.

Upon successful completion of the course the student will be able to:

1. Critically understands the current trends in the scientific field of Cloud Computing technology and its connection with the science of Electrical and Electronic Engineering,
2. Understands the basic models based on services (IaaS, PaaS, SaaS), but also their separation based on their development (Public, Private) that govern Cloud Computing.
3. Understands the concept and techniques of Virtualization, Containerization, Dockerization, and be able to understand their differences.

4. Understands how the tools that achieve virtualization work as well as how to manage system resources.
5. Understands the concept of «Hypervisor» and can describe the different types of them as well as their basic characteristics.
6. Understands the concept of Software Defined Networks (SDNs) and their key features.
7. Creates and uses cloud infrastructure for application development.
8. Understands the different application implementation architectures (Monolithic Architecture, Architecture implemented with services, Architecture implemented with micro-services) and be able to document their respective advantages and disadvantages.
9. Selects and implements after critical thinking, the most appropriate application architecture depending on the case.
10. Uses the Docker toolkit (Docker Container, Docker Image, Docker file, Docker Registry, Docker Compose, Docker Swarm, Docker Stack) to implement applications with microservices.
11. Compares different cloud service development platforms (Openstack, Synnefo, Eucalyptus etc.)
12. Compares and implements cloud computing applications in different cloud service providers (Amazon Web Services - AWS, Microsoft Azure, Google Cloud Platform - GCP, Okeanos etc.)
13. Understands the concept of IT automation and be able to work alone or collaborate with fellow students or other engineers on the installation and operation of IT automation solutions.
14. Demonstrates specialized problem-solving skills, adopts innovative solutions and develops new knowledge in the field of Cloud Computing,
15. Collaborates with colleagues for the integrated confrontation of complex problems, the critical evaluation of alternative solutions and the decision-making to be implemented in the field of Cloud Computing.

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
Adapting to new situations
Decision-making
Working independently
Team work
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project planning and management
Respect for difference and multiculturalism
Respect for the natural environment
Showing social, professional and ethical responsibility and sensitivity to gender issues
Criticism and self-criticism
Production of free, creative and inductive thinking

1. Search, analysis and synthesis of data and information, using the necessary technologies
2. Autonomous Work
3. Work as a member of a team (Teamwork)
4. Promoting free, creative and inductive thinking

3. SYLLABUS

Theoretical Part

Section 1: Introduction to Cloud Computing: service models and development models
Basic principles of operation of cloud computing infrastructure. Differences with the classic data centers, analysis-comparison of service models (IaaS, PaaS, SaaS), analysis / comparison of cloud cloud infrastructure development models (Public, Private, Community, Hybrid clouds).

Section 2: Virtualization and Cloud Computing: operating principles, virtualization modes and hypervisors
Presentation of virtualization technology, analysis of virtualization methods, use of virtualization in the field of Cloud Computing, presentation of the role of the hypervisor and its basic features, presentation of popular hypervisor.

Section 3: Cloud Computing Technologies and Platforms
Presentation of Cloud Solutions in the IaaS model such as Microsoft Azure, Amazon Web Services, Google Cloud Platform, OpenStack. Presentation of cloud computing solutions in the PaaS model such as Herokou, OpenShift, Google App Engine. Presentation of cloud solutions in SaaS model such as Dropbox, Google Drive, SpiderOak One.

Section 4: Software Defined Networks and Network Function Virtualization
Presentation of SDN and NFV technologies, analysis of how they work and their main features, use of SDNs in cloud computing, presentation of Openflow and Open vSwitch, NVP and VDS.

Section 5: Use of Containers
Presentation of the container technology and its basic features. Presentation of Docker technology and instrumentation machines used such as Kubernetes, Docker Swarm and Mesos. Comparison of virtual machines with containers.

Section 6: Best Practices for Creating Cloud Infrastructure with High Availability (HA)
Design and architecture of cloud infrastructure in order to achieve HA, elimination of Single Point of Failures (SPOFs) and presentation of failover techniques.

Section 7: Examples of Real Cloud Computing Infrastructure
Use of Okeanos virtual machines. Demonstration of Hypervisor installation with KVM in infrastructure of the TelSiP research team. Demonstration of the OpenStack infrastructure of the CONSERT research team.

Section 8: Use of IT automation Mechanisms
Key features of IT automation technologies and their role in Cloud Computing infrastructure, assignment of group or individual work on the design and implementation of an application using IT automation mechanism (e.g. Ansible).

Hands-on Labs:

The preparation of the students both for the elaboration of their semester work (project), and for the deeper understanding of the theoretical and practical part of the course, is done by performing a number of laboratory exercises (Hands-on Labs) in real infrastructures of the University or/and GRNET (grnet.gr), focused on the main subjects of the theoretical teaching. The practice exercises will be focused on the following areas:

1. Introduction to Cloud Computing
2. Access to Cloud Computing infrastructure (Infrastructure as a Service)
3. Deployment of a web application on a cloud platform (Platform as a Service)
4. Introduction to Containers and the Docker toolbox (Docker Container, Docker Image, Docker Network, Docker Storage, Dockerfile, Docker Registry, Docker Compose, Docker Swarm, Docker Stack)
5. Install and use the docker toolbox
6. Examples of creating a simple application with docker
7. Install and use the docker-compose toolbox
8. Examples of creating applications with docker-compose

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	• Face-to-face (main way), • Distance learning (supplementary way)
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	• Use of slides with multimedia material in the classroom, • Learning process support through the course website (e-class platform) supplementary material, notes, • Demonstration and implementation of applications with docker and docker-compose in the cloud infrastructure of okeanos.grnet.gr • Communication with students electronically, through the course website (e-class platform) • Wiki system for the Course (e-class platform)
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*	Teaching is organized into lectures, exercises / work and study.

Activity	*Semester Workload*
Lectures	52
Study of lecture material and bibliography analysis	26
Study of the material of the Practice Exercises	13
Practice Exercises (Hands-on Labs)	26
Individual or Group Project preparation and presentation	13
Study and preparation for exams	20
Course Total	**150**

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.*	The final overall evaluation is completed at the end of the lectures and includes: (a) the mid-term evaluation (individual or group project), (b) the evaluation of the Hands-on Lab of the course, and (c) the final written examination in the taught material. More detail: • The mid-term evaluation (30%) takes place around the middle of the semester and includes the documentation and presentation of one or more individual or group exercises focusing on Cloud Computing implementations. • The evaluation of the Hands-on part (40%) is done after the completion of the practical exercises, with oral or written final examination in the whole material of the Hands-on part, using the Cloud infrastructure of the University. • The final written examination (30%) takes place in Greek, without notes, in the whole material.

5. BIBLIOGRAPHY

-Recommended Bibliography :

1. Poulton, Nigel. Docker deep dive. JJNP Consulting Limited, 2019.
2. Al-Saidi, Asma, et al., eds. Intelligent Cloud Computing: First International Conference, ICC 2014, Muscat, Oman, February 24-26, 2014, Revised Selected Papers. Vol. 8993. Springer, 2015. (Κωδικός Εύδοξου: 73264373)
3. Ruparelia, Nayan B. Cloud computing. Mit Press, 2016. (ISBN: 978-0262529099)
4. Rafaels, Ray J. Cloud Computing: From Beginning to End. CreateSpace Independent Publishing Platform, 2015.
5. Bahga, Arshdeep, and Vijay Madisetti. Cloud computing: A hands-on approach. CreateSpace Independent Publishing Platform, 2013.
6. Erl, Thomas, Robert Cope, and Amin Naserpour. Cloud computing design patterns. Prentice Hall Press, 2015.
7. Thomas, Erl, Mahmood Zaigham, and Puttini Ricardo. "Cloud Computing Concepts, Technology & Architecture.", 2013.
8. Lecture Material

- Related Scientific Journals:

- IEEE Transactions on Cloud Computing
- IEEE Cloud Computing