Course Title	**DISTRIBUTED AND CLOUD COMPUTING**				
Course Code	**DLWSS504**				
Course Type	**Compulsory**				
Level	Master (2nd Cycle) – Distance Learning				
Year / Semester	1 / 1				
Teacher's Name	**Achilleas Achilleos, PhD**				
ECTS	10	Lectures / week	3	Laboratories/week	0
Course Purpose	The aim of this course is to provide students with critical understanding on the evolution path towards distributed systems and cloud computing. The course addresses the concepts, methods, technologies and tools for cloud setup, management and deployment of applications. Initial topics covered in the course include parallel and distributed computing, their differences, as well as the concepts of utility and cloud computing. Then, the cloud computing levels, models and the cloud architecture are introduced. Following the cloud service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) & Software as a Service (SaaS) are defined and presented in detail. The course proceeds to introduce the concepts of abstraction and virtualization, the notion of virtual machines, machine images and containers. The basic concepts of the concept of capacity planning, metrics and baselines for the scaling of cloud systems are introduced, as well as multi-cloud the differences and benefits of multi-cloud development in comparison to utilizing a single cloud provider are explained. These concepts are then presented in practice via an overview of the OpenStack and Azure cloud environments. The course has a theoretical underpinning, but practical examples are also performed that reveal how to setup and manage an OpenStack private cloud or an Azure public cloud using the introduced implementation methods, techniques and tools. The course concludes with the introduction of Serverless Computing that aims to be the realisation of the cloud computing vision of utility computing. This course aims to cultivate knowledge of the essential principles, methods and tools to: ● Critically assess, understand and describe the evolution path towards distributed systems and cloud computing. ● To perform in practice the cloud setup, management and deployment of software applications.				
Learning Outcomes	By the end of the course the students are expected to: ● Describe and explain the concepts, as well as the differences between parallel, distributed, utility, cloud and serverless computing.				

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Outline the layers of the cloud computing stack and define the main cloud computing levels; infrastructure, platform and software.
Understand and present the different cloud computing types: cloud deployment models and cloud service models.
Critically discuss service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) & Software as a Service (SaaS).
Learn and understand the concepts of abstraction and virtualization, virtual machines, machine images and containers.
Learn the basic concepts of the concept of capacity planning, metrics and baselines for the scaling of cloud systems.
Understand the differences and benefits of multi-cloud development in comparison to utilizing a single cloud provider.
Learn the basic concepts of the OpenStack cloud environment and install, configure and use it to setup a private cloud.
Learn the basic concepts of the Azure public cloud environment and utilise DevOps tools and APIs to create images, deploy applications and manage them through shell scripting.
Describe and explain the concepts, as well as the differences between parallel, distributed, utility, cloud and serverless computing.

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<tr><td>Prerequisites</td><td>None.</td><td>Corequisites</td><td>None.</td></tr>
<tr><td>Course Content</td><td colspan="3">This course consists of six units that will be taught within twelve (12) weeks:

Unit 1 (Week 1) is about Introduction to Cloud Computing (1 Week) that involves the topics of Parallel and Distributed Computing, distributed systems, cloud computing, cloud types – cloud deployment and cloud service models – overview, understanding the paradigm shift towards cloud computing and the benefits and disadvantages of cloud systems.
Unit 2 (Week 2) covers he Cloud Computing Stack, introducing the elements of the Cloud Architecture, describing the different cloud models in detail, presenting how platforms and virtual appliances are used, the cloud communication protocols and finally an overview of the new class of cloud-connected clients such as Google Chrome OS.
Unit 3 (Week 3) presents the cloud services and applications by type, including creating clouds with Infrastructure as a Service (IaaS), working with Software as a Service (SaaS), developing applications on a Platform as a Service (PaaS) and securing cloud transactions with Identity as a Service (IDaaS).
Unit 4 (Week 4) covers the topic of Abstraction and Virtualization, presenting the connection between abstraction and cloud computing, the notion of virtualization and shared resource pools, the concept of Load balancing to enable large cloud computing applications, the concepts of Hypervisors and virtual machines and finally system imaging and application portability for the cloud.
Unit 5 (Week 5) provides an overview of Capacity Planning for the cloud, introduces capturing baselines and metrics, determining resources and their ceilings, as well as Scaling your systems

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	appropriately. • Unit 6 (Week 6) delivers an introduction to Multi-Cloud, the definition of Multi-Cloud, the concepts, definition and issues of Cloud, the Importance of Multi-Cloud, introducing a Simple Multi-Cloud Architecture, overview of Multi-Cloud Deployment Software Toolkits, e.g., Apache jClouds. • Unit 7 (Weeks 7-8) presents theoretically and in practice the OpenStack Cloud Environment, introducing the basics of OpenStack, the OpenStack Architecture, the Services, the OpenStack Private Cloud Setup, the Cloud Inventories and Management, the OpenStack Documentation and the OpenStack Clients. • Unit 8 (Weeks 9-11) introduces in theory and practice the Azure Public Cloud, starting with the basics of Azure, the different Azure Cloud Management Methods, the Azure PowerShell Az module in Windows and Linux environments for connecting to Azure, creating and Managing Resources using shell scripting. • Unit 9 (Week 12) provides an overview of the state of the art topic of Serverless Computing, beginning with the definition of Serverless Computing, history and related work, the serverless architecture and programming model, the tools and frameworks available and the technical and research challenges to deliver the vision of serverless computing. The course also includes the final revision week for the entire content of the course (Week 13).
Teaching Methodology	**Mode of Delivery: Distance Learning** The course is designed to introduce and explain the material students are expected to learn through an on-line learning environment. The on-line environment provides an opportunity for receiving on-line feedback from the Course Instructor during their study. In addition, students will be encouraged to interact both with other students and the instructor so as to feel part of an on-line community of learners that belong to the University network. The course content will be delivered through online material/notes, recorded lectures and/or narrated presentations. Therefore, students may be asked to download and study notes, tutorials and numerical exercises as well as watch recorded lectures/demonstrations or narrated presentations posted on the web addressing the main concepts of a particular unit. Furthermore, the planned communication and the dynamic/online interaction activities between the course instructor and the students will include asynchronous communication tools (Discussion Forum) that students may be asked to participate, wherever appropriate, in an online forum posting their views on certain topics covered in a particular unit; and synchronous communication tools (instant messaging, such as Skype, chat rooms, video-conferencing, etc.), that students may discuss on-line with the Instructor (s) and/or other students specific issues covered in a given unit. Moreover, a number of case study readings are also considered, so as to demonstrate the relevance and practical applicability of mobile and ubiquitous computing methods and systems covered in the various units of

	this course. Case-studies can illustrate that what students have studied in each unit is not just of academic or theoretical value but also has value in terms of improving real-life challenges.
Bibliography	**Compulsory Bibliography** **1.** Barrie Sosinsky, "Cloud Computing Bible", Book: Copyright © 2011 by Wiley Publishing, Inc., Indianapolis, Indiana, ISBN: 978-0-470-90356-8. **2.** Ali Sunyaev**, "**Internet Computing, Principles of Distributed Systems and Emerging Internet-Based Technologies", Springer Nature Switzerland AG2020, 2020, https://doi.org/10.1007/978-3-030-34957-8. **Additional / Complimentary Bibliography** 1. Dana Petcu, "Multi Cloud: expectations and current approaches", In Proceedings of the 2013 international workshop on Multi cloud applications and federated clouds (MultiCloud '13). ACM, New York, NY, USA, 1 6. DOI: 10.1145/2462326.2462328. 2. M. A. AlZain, E. Pardede, B. Soh and J. A. Thom, "Cloud Computing Security: From Single to Multi clouds", 45th Hawaii International Conference on System Sciences, Maui, HI, 2012, pp. 5490 5499. DOI: 10.1109/HICSS.2012.153. 3. K. Hui, D. Radez, "Getting Started With OpenStack", RackSpace, Available Online: https://www.openstack.org/assets/presentation-media/Getting-Started-With-OpenStack-Icehouse-v2.pptx . 4. OpenStack.org, "OpenStack Documentation", Available Online: https://docs.openstack.org/train/. 5. Microsoft, "Azure Documentation", Available Online: https://docs.microsoft.com/en-us/azure/.
Assessment	The Students are assessed via continuous assessment throughout the duration of the Semester, which forms the Coursework grade and the final written exam. The coursework and the final exam grades are weighted 50% and 50%, respectively, and compose the final grade of the course. Various approaches are used for the continuous assessment of the students, such as dynamic online activities, online quizzes, group project design, implementation and presentation. The assessment weight, date and time of each type of continuous assessment is being set at the beginning of the semester via the course outline. An indicative weighted continuous assessment of the course is shown below: • **1st Online activity – Online Quiz** (10% of total marks for module) • **2nd Online activity – Research Papers Study & online quiz** (10% of total marks for module) • **Two marked assignments** (30% of total marks for module) • **One closed-book, 3-hour final exam** (50% of total marks for module) Students are prepared for final exam, by revision on the matter taught, problem solving and concept testing and are also trained to be able to deal with time constraints and revision timetable.

	The criteria considered for the assessment of each type of the continuous assessment and the final exam of the course are: (i) the comprehension of the fundamental concepts and theory of each topic, (ii) the application of the theory in solving related problems and (iii) the ability to apply the above knowledge in complex real-life problems. The final assessment of the students is formative and summative and is assured to comply with the subject's expected learning outcomes and the quality of the course.
Language	**English.**