

ECE-530: Cloud Computing 3 Credit Hours
Instructor: Ioannis Papapanagiotou
Instructor email: ipapapa@unm.edu
Department ECE Building Room 125
Department Contact: 505-277-2436

Course Description

This course provides an introduction in the techniques and technologies used in cloud computing. It consists of independent and intensive hands on labs. The course emphasizes on architecture and the development of web services that can scale on cloud infrastructure. The students learn how to deploy an IaaS, develop applications against common PaaS vendors. Students or attendees learn how to focus on service decoupling and the principles of a cloud native enterprise. Below we show some of the modules offered in this course.

Topics Covered

- Introduction to Cloud Computing - standardization, automation, rapid elasticity, pricing
- Cloud Architectures and Model (Service and Delivery Models, Virtualization, Hypervisors)
- IaaS and PaaS Cloud Services and Vendors (Amazon AWS, OpenStack, Google Cloud and Microsoft Azure etc.)
- Anatomy of the Cloud (Cloud tiers, Sharding, CAP Theorem, ACID/Base, Web Services)
- Replication, Consistency, 2/3 Phase Commits, and Paxos (Vector Clocks, Byzantine Failures, Chandy/Lamport)
- PaaS Cloud Storage and Case Studies (The Amazon Dynamo/Cassandra, Google's BigTable etc)
- Data Pipeline (Distributed Queues, Message Brokers, Pub/Sub, Service Decoupling, Exchange Types and Apache Kafka)
- Microservices, Containers, Container Orchestration (Control Groups, Namespaces, Docker, Kubernetes, Docker Swarm, Meson with Marathon)
- Network Virtualization (OpenStack Neutron, Software Defined Networks, OpenFlow)
- Security (security integration model, threats, Economic Denial of Sustainability, threat mitigation and case studies)
- Serverless (Function As a Service - FaaS)

Course Objectives

The goal of this course for the students (1) to develop the ability to explain the shift of physical infrastructure towards a virtualized one such as Cloud computing and be able to answer critical questions on when and why migrating services on the cloud. (2) The students will analyze the cloud platform and formulate a monolithic application to microservices. (3) Students will practice the cloud computing layers, data ingestion and data storage on the cloud and the layers of the computing services (including instances, containers and serverless).

Prerequisites and Co-requisites

Graduate and or undergraduate course in computing networks (ECE 440 ECE 540 or equivalent) and Unix/Linux background. Background of Operating Systems (ECE 437 / CS 481, CS587) is not a requirement but it is good to have.

Technical Skills

In order to participate and succeed in this class, you will need to be able to perform the following basic technical tasks:

- Use UNM Learn (help documentation located in "How to Use Learn" link on left course menu, and also at <http://online.unm.edu/help/learn/students/> (URL));
- Download and install a VM hypervisor such as VirtualBox/VMware Client and be able to spin up a Virtual Machine with a Linux OS;
- Be competent in working in a Unix/Linux environment;
- Interpret how computing resources are being used within the laptop and VM (e.g. CPU, RAM, Disk Drive etc.);
- Have technical expertise in IP addresses and subnets and have knowledge on how to configure them.

Technical Requirements

A high-speed Internet connection is a requirement (Wireless/Wired).

Computer

As the course puts strong emphasis on hands-on experiences and practical training in deploying cloud services, your assignments require you to use virtual resources. Hence, in addition to the above requirements, students are expected to have full access to a computer that meets or exceeds the following capabilities to accomplish the projects of this course:

- Processor with at least 2 cores (recommended is 4+ cores).
- Minimum 6 GB RAM (recommended is 8GB of RAM)
- Minimum 64GB free hard disk space
- OS that is supported by VirtualBox or VMware Client (Windows, Linux or Mac OS X)

We recommend that you install a hypervisor, such as VirtualBox or VMware Client. The above hardware requirements are for a smooth experience with the virtual machines. For more information on VirtualBox, refer to <http://www.virtualbox.org/>

For UNM Learn Technical Support: (505) 277-0857 (24/7) or use the "Create a Support Ticket" link in the course.

Web Conferencing

Zoom will be used for this course for the office hours. The instructor will notify students 5 business days in advance for any optional office hours.

For the online sessions, you will need:

- A USB headset with microphone. Headsets are widely available at stores that sell electronics, at the UNM Bookstore or online.
- A high-speed internet connection is highly recommended for these sessions. A wireless Internet connection may be used if successfully tested for audio quality prior to web conferencing.

Tracking Course Activity UNM Learn automatically records all students' activities including: your first and last access to the course, the pages you have accessed, the number of discussion messages you have read and sent, web conferencing, discussion text, and posted discussion topics. This data can be accessed by the instructor to evaluate class participation and to identify students having difficulty

Textbook and Supplemental Materials

The instructors will provide the appropriate notes from the course. Additional articles and papers to read will be posted. I would highly recommend optionally buying the following book:

- *Designing Data-Intensive Applications: The big ideas behind reliable, scalable and maintainable systems*, By M Kleppmann, ISBN-13: 978-1449373320

There are a few other books in the domain for generic reading:

- *Architecting the Cloud: Design Decisions for Cloud Computing Service Models* (SaaS, PaaS, and IaaS), By Kavis et.al, ISBN-13: 978-1118617618.
- *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things*, By K. Hwang et al., Elsevier 2012, ISBN-13: 978-0123858801
- *Docker Up and Running*, By Matthias et al., ISBN-13: 978-1491917572

Coursework and Participation

Instructor Response Time

Course messages are checked daily Monday through Friday and all messages will be responded to within 72 hours. If you do not hear from the instructor within 72 hours, please send your message again.

Posting of grades: Grades of submitted work will be posted and available via My Grades in Learn within five (5) business days of the due date.

Procedures for Completing Coursework

- For remote exams, we will use UNM Learn.
- There will be no makeup exams or homework.
 - Late submissions will lose 10% of the corresponding grade of the submission per 24h.
- All written work needs to be submitted online. If you have difficulty using UNM Learn, please create a support ticket (using the course menu) and notify your instructor as well.

Assignments

Exemplar assignments (more information can be found on UNM Learn):

- Quizzes per module
- Compare and contrast public cloud providers

- Deploy an IaaS
- Learn microservices and container deployments
- Distributed systems on Containers

Expectations for Participation

Student Expectations:

- time required (10-18 hrs per week)
- students are expected to learn how to navigate in Learn
- students are expected to communicate with one another in team projects
- students are expected to keep abreast of course announcements
- students are expected to use the Learn course messages as opposed to a personal email address
- students are expected to keep instructor informed of class related problems, or problems that may prevent the student from full participation
- students are expected to address technical problems immediately
- students are expected to observe course netiquette at all times
- Students are expected to learn how to navigate in UNM Learn before the beginning of the course
- Students are expected to monitor UNM Learn for announcements on bi-weekly basis
- Students are expected to check their emails once every 24h and course messages once every 48h.
-

Netiquette

- Netiquette refers to a set of guidelines in online communication that help to ensure positive interactions. These guidelines seek to keep this online class a positive learning environment for everyone.
- [Link to Netiquette document](#)

Grading Procedures

- Hands on Lab/Homework (total 4 – 10% each): 40%
- Assignments (Quizzes & Reading Assignments): 40%
- Midterm Exam: 20%
- (no final exam)

Grading Scale

Undergraduate grading scale

A+ [97-100+	B+ [87-90)	C+ [77-80)	D+ [67-70)	
A [94-97)	B [84-87)	C [74-77)	D [64-67)	
A- [90-94)	B- [80-84)	C- [70-74)	D- [60-64)	F 59 or Below

Graduate grading scale

A+ [97-100+	B+ [87-90)	C+ [77-80)	F [0-74)
A [94-97)	B [84-87)	C [74-77)	
A- [90-94)	B- [80-84)		

UNM Policies

Title IX: Gender Discrimination

In an effort to meet obligations under Title IX, UNM faculty, Teaching Assistants, and Graduate Assistants are considered “responsible employees” by the Department of Education (see pg 1-2, <https://www2.ed.gov/about/offices/list/ocr/docs/qa-title-ix-201709.pdf>). This designation requires that any report of gender discrimination which includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA must be reported to the Title IX Coordinator at the Office of Equal Opportunity (oeo.unm.edu (URL)).

For more information on the campus policy regarding sexual misconduct, see:

<https://policy.unm.edu/university-policies/2000/2740.html> (URL)

Copyright Issues

All materials in this course fall under copyright laws and should not be downloaded, distributed, or used by students for any purpose outside this course.

Accessibility

The American with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodations of their disabilities. If you have a disability requiring accommodation, please contact the UNM Accessibility Resource Center in 2021 Mesa Vista Hall at 277-3506 or <http://arc.unm.edu/> (URL) . Information about your disability is confidential.

- Blackboard’s Accessibility statement: <http://www.blackboard.com/accessibility.aspx> (URL)
- Microsoft: <https://www.microsoft.com/enable/microsoft/mission.aspx> (URL)

Academic Misconduct

You should be familiar with UNM’s [Policy on Academic Dishonesty](#) (URL) and the [Student Code of Conduct](#) (URL) which outline academic misconduct defined as plagiarism, cheating, fabrication, or facilitating any such act.

Drop Policy:

This course falls under all UNM policies for last day to drop courses, etc. Please see [the student information](#) or the UNM Course Catalog for information on UNM services and policies. Please see the UNM academic calendar for course dates, the last day to drop courses without penalty, and for financial disenrollment dates.

Contingency for course-wide system failure: Learn has regularly scheduled updates during which time the system is down. This course has been designed to avoid due dates or times that conflict with these updates, but you should plan to do your course work around those scheduled times. Unexpected system outages are rare, but if they occur, I will advise everyone on how to proceed.

UNM Resources

CAPS Tutoring Services <http://caps.unm.edu/services/online-tutoring/online-writing-lab.php>
(URL)

UNM Libraries <http://library.unm.edu> (URL)

Student Health & Counseling (SHAC) Online Services <http://shac.unm.edu/> (URL)