Course #: Cloud Administrator

**Course Description & Syllabus**

Name of College or University

Semester Year

# Overview

**Title:** Cloud Administrator  
**Credits/Units:** 3-credit hours or 4-credit hours with a lab.  
**Pre-requisites:** Introduction to Computing.

**Institution LMS access:** [https://lms.univ-or-college.edu](https://canvas.cmu.edu)

**Recitation:**

1. **Tuesday, 8:00 AM – 8:50 AM ET, BLDG XYZ (Videotaped)**

**Teaching Staff:**

| [**Prof. Best Faculty**](http://www.xyz.edu/...)[faculty-email@xyz.edu](mailto:faculty-email@xyz.edu) Office Number, +1-555-555-5555 *Office hours:*Tuesday, 3-4pm (time zone) |  |
| --- | --- |
| TAs typically hold office hours in building/room. The TA office hours are posted on the LMS:   * TA Name<ta-email@xyz.edu> | * TA Name<ta-email@xyz.edu> |

# Course Description

Students will gain knowledge and develop hands-on experience solving real-world problems in the area of cloud administration. This includes the process to provision, orchestrate, scale, manage and monitor cloud services across compute, storage, networking, and security using various cloud interfaces. All projects utilize existing public cloud infrastructure, tools, and services. Specifically, students will be exposed to real-world scenarios, infrastructure, and data. It is our goal that students will develop the skills needed to become a cloud administrator.

# Course Goals

In this course, students gain hands-on experience solving real world problems by completing projects in the areas of identity management, resource provisioning and configuration, scaling, orchestration, monitoring, security, and disaster recovery, which utilize existing public cloud tools and services. It is our goal that students will develop the skills needed to become a practitioner in the domain of cloud administration. Specifically, students are exposed to real-world data, scenarios, infrastructure and budgets in order to learn how to:

1) Identify and suggest appropriate cloud services to deploy cloud-based applications or services;

2) Propose and implement cloud-based identity management solutions;

3) Provision, configure, deploy, monitor, scale, and manage cloud-based web applications;

4) Orchestrate, secure and recover cloud-based web applications;

Through this process, we aspire for our students to become sophisticated, independent, and resilient problem solvers who are able to overcome challenges and learn.

# Learning Outcomes

In this project-based course, we have project and conceptual learning objectives.

# Project Learning Objectives

The project learning objectives (LOs) are the following. Students will be able to:

1. Create, configure and manage cloud accounts, subscriptions, user and service identities.
2. Set and manage role-based access control (RBAC) based on a set of specifications.
3. Configure, create, and manage compute, networking and storage cloud resources and set their policies and access.
4. Apply cloud scaling solutions to deploy a load-balanced web application on the cloud.
5. Create, configure, deploy, manage and monitor cloud resources through cloud orchestration tools.
6. Utilize monitoring telemetry, metrics, and alerts for cloud resources to improve the reliability and availability of cloud applications.
7. Create, configure, and manage virtual networks, subnets, security groups, and IP addresses.
8. Employ cloud backup, redundancy, and recovery services to deploy cloud-based fault-tolerant services.

# Conceptual Learning Objectives

The conceptual learning objectives (LOs) are the following. Students will be able to:

1. Explain the core concepts of the cloud computing paradigm and discuss how and why the cloud paradigm shift came about.
2. Explain the characteristics of various models and services in cloud computing and discuss their advantages and challenges.
3. Describe the software layers that enable building and deploying cloud applications that are scalable, resilient, elastic and cost-efficient.
4. Explain how identity management enables access control for users, groups, and roles for organizations.
5. Discuss how automation, orchestration and managed services enhance the management of cloud-based deployments.
6. Explain the use of metrics, telemetry, alerts, notification, and dashboards to monitor complex cloud deployments.
7. Enumerate and explain cloud security threats, control, and auditing.
8. Discuss cloud failure patterns and the use of redundancy, replication and disaster recovery and backup services to provide fault-tolerant cloud-based applications.

# Course organization

Your participation in the course will involve several forms of activity:

1. Reading the conceptual content for each unit.
2. Completing the graded weekly assessments after each unit.
3. Complete projects, which are hands-on training and automated feedback.

# Getting help

Students are encouraged to ask questions about content and projects through the Q & A forum. The course link for the forum is:

[http://Q&A-forum.edu/](http://piazza.com/cmu/spring2020/1531915619/home)

# Policies

###### Working Alone on Projects

Projects that are assigned to single students should be performed individually.

###### Handing in Projects

All assessments are due at 11:59 PM ET (one minute before midnight) on the due dates specified on the Sail() Platform. All hand-ins are electronic.

###### Appealing Grades

After each project module is graded, you have seven calendar days to appeal your grade. All your appeals should be provided by email to the professor.

# Assessment

Inline activities (“Learn by Doing” and “Did I Get This”), which are available in most pages in the OLI course, are simple, non-graded activities to assess your comprehension of the material as you read through the course material. You are advised to complete all of the inline activities before proceeding through to the next page or module. If you missed many of the activities, it is recommended that you review the material again.

The conceptual units consist of modules of content on OLI, each week has a Checkpoint Quiz that you must complete before the deadline posted on OLI. Each weekly Checkpoint Quiz will be worth N% of your total grade. It is your responsibility to ensure that the quiz is submitted prior to the deadline. You will have only a single attempt to complete each Checkpoint Quiz on OLI.

This course includes several individual projects. Each project module has to be completed based on the deadlines posted on Sail(). The write-up required to complete each project module is available on Sail(). Each module has a submission process that is specific to the project module that is due. It is the students’ responsibility to make sure that all project work is completed and that the project module is submitted prior to the deadline. Students typically have multiple attempts to submit the project module on Sail().

| Type | | Number | Weight |
| --- | --- | --- | --- |
| Conceptual Content Quizzes | | 8 | XX% |
| Projects | | 8 | YY% |
| Total Grade | |  | 100% |

# Cheating

We urge each student to carefully abide by the course policy on academic integrity, which outlines the policy on cheating, plagiarism or unauthorized assistance. It is the responsibility of each student to produce her/his own original academic work. Collaboration or assistance on academic work to be graded is not permitted unless explicitly authorized by the course instructor. Each unit checkpoint quiz or project module submitted must be the sole work of the student turning it in. Student work on the cloud is logged, submitted work will be closely monitored by automatic cheat checkers, and students may be asked to explain any suspicious similarities with any piece of code available. The following are guidelines on what collaboration is authorized and what is not:

###### What is cheating?

1. Sharing a solution, code or other electronic files by either copying, retyping, looking at, or supplying a copy of any file. Copying any solution, code from the internet (stackoverflow.com or github or others). Do not use other students’ solutions or code to “test” the auto-grader. Anything you submit to the auto-grader must be your work.
2. Copying answers to any checkpoint quiz from another individual, published or unpublished written sources, and electronic sources.
3. Collaborating with another student or another individual on checkpoint quizzes or project modules.
4. Sharing written work, looking at, copying, or supplying work from another individual, published or unpublished written sources, and electronic sources.
5. Collaboration in team projects is strictly limited to the members of the team.

###### What is **not** cheating?

1. Clarifying ambiguities or vague points in class handouts.
2. Helping others use computer systems, networks, compilers, debuggers, profilers, or system facilities.
3. Helping others with high-level design issues.
4. Guiding others through code debugging but not debugging for them.

Cheating in projects will also be strictly monitored and penalized. Be aware of what constitutes cheating (and what does not) while interacting with students. You cannot share or use solutions, written code, and other electronic files from students. If you are unsure, ask the teaching staff.

Be sure to store your work in protected directories. The penalty for cheating is severe, and might jeopardize your career – cheating is simply not worth the trouble. By cheating in the course, you are cheating yourself; the worst outcome of cheating is missing an opportunity to learn. In addition, you will be removed from the course with a failing grade. We also place a record of the incident in the student’s permanent record.

# Conceptual Topics

The course content will be structured into the following modules:

| Module | Title | Learning Objectives |
| --- | --- | --- |
| 1 | Cloud Overview | * Explain the concept of cloud computing * Briefly understand how computing systems across domains dealt with scale before the cloud * Briefly recall the recent history of cloud computing, illustrating its evolution * Recognize cloud service models such as IaaS, PaaS, and SaaS and differentiate between them * Enumerate the different types of clouds, and compare and contrast them * List some of the common cloud providers and the features offered in their cloud stacks * Articulate the economic benefits of the cloud paradigm for cloud users and cloud service providers * Discuss some of the advantages and disadvantages of the cloud paradigm * Define SLAs and SLOs and describe their importance in Cloud Computing * Recall popular cloud use case scenarios |
| 2 | Provisioning and Managing Cloud Services | * Describe the different types of services available from cloud providers and list some examples of the kinds of services they provide * Recall the various features provided by cloud middleware * Describe the resource provisioning process from the context of a cloud service provider * Discuss approaches to organizing cloud resources and the benefits of doing so * Recall the issues related to resource metering for cloud service providers |
| 3 | Identity Management and Access Control | * Explain the concept of digital identity and the purpose of a directory service * Describe the purpose of users and user groups in an identity-management system * Explain how synchronization and federation can be used to extend identities beyond organizational boundaries * Discuss the advantages of using guest identities to authenticate users external to the organization * Discuss the use of role-based access control (RBAC) to secure access to resources |
| 4 | Virtualization in the Cloud | * Identify the two main types of virtual machines and provide examples of each * Identify major reasons that virtualization is an essential technology for cloud computing * List the key advantages that containers have over virtual machines * Understand key terms such as Docker containers, container images, and container registries * Identify some of the ways in which major cloud platforms support containers * Recall key design considerations for data-center networks and describe the need for network virtualization to support multiple tenants |
| 5 | Elasticity in the Cloud | * Describe common load patterns and how they drive the need to scale * Enumerate the strategies and considerations in scaling cloud applications * Discuss the advantages of auto-scaling and the mechanisms used to achieve it * Describe the importance of load balancing in cloud applications and enumerate various methods to achieve it * List the primary benefits of serverless computing and explain the concept of serverless functions |
| 6 | Automation, Configuration and Orchestration | * Identify the advantages and disadvantages of automating cloud deployments by scripting commands * Explain the concept of Infrastructure-as-Code and enumerate the advantages that it offers over ordinary scripting * List some of the tools that implement IaC for popular cloud platforms and describe some of the differences between them * Understand Terraform’s role as an infrastructure orchestrator and describe how it differs from a conventional configuration manager |
| 7 | Resource Monitoring | * Explain the main argument in favor of continual and consistent monitoring and oversight in cloud-based IT systems * Describe the three types of quantitative measurements that play a role in monitoring * Understand the mechanics of monitoring platforms that utilize agents to collect and report back information * Understand the mechanics of monitoring platforms that rely upon pre-existing sources of information such as service logs to analyze performance * Understand the metrics that are the most beneficial to monitoring * Learn how measurements are used to judge performance levels * Describe the justification for problem ticketing * Describe what KPIs are and how they differ from metrics * Discuss the concept of “everyday remediation” |
| 8 | Cloud Security | * Understand the importance of risk assessment in implementing cloud security * Understand how cloud customers and cloud service providers share responsibility for security * List some of the prominent threats to cloud security * Understand the role that cryptography plays in securing data * Understand the difference between symmetric encryption and asymmetric encryption * Understand how public key cryptography facilitates the secure exchange of data * Explain the concept of multilayered data security and why it is necessary * Explain some of the services offered by data-security platforms and the integrated security services offered by cloud service providers * Understand why regulatory compliance is important and list some of the regulations that may apply |
| 9 | Disaster Recovery and Backup | * Understand the meaning of “fault tolerance” * List reactive techniques used to achieve fault tolerance in cloud platforms * List proactive techniques used to achieve fault tolerance in cloud platforms * Understand the backup services offered by leading cloud service providers * Understand the role that backup services play in disaster response and recovery * Explain the difference between backup services and disaster-recovery services * List the service-level objectives that drive disaster-recovery planning * List the disaster-recovery services offered by leading cloud service providers * Explain what resilience is and how it is measured * Explain how resilience contributes to business continuity |

# Projects

The projects are geared towards providing hands-on experience. Students will learn to develop all projects using various public cloud services. For each project, students are expected to work within a specified budget otherwise they risk being penalized, and fulfill the following learning objectives.

# Project 0: Account and Subscription Setup

* Set up an Azure account and an Azure subscription.
* Practice using the Azure Cloud Shell and Azure CLI.
* Examine the details of Azure account and subscription.
* Explore the Azure quickstart to create a static HTML web app.
* Experiment using the Azure portal to create a virtual machine.
* Experiment hosting a web service on a virtual machine.

# Project 1: Subscription and Resource Group Management

* Explain the definition and purposes of an Azure subscription.
* Describe the relationship between Azure subscriptions and resource groups.
* Interpret how Azure subscriptions are used in real-world scenarios.
* Practice to provision virtual machines with the Azure CLI.
* Practice moving resources between subscriptions with the Azure CLI.

# Project 2: Azure Active Directory

* Explain the definition and purpose of Azure Active Directory (aka Azure AD or AAD).
* Explain the definition of a domain name in the Azure Active Directory.
* Manipulate the association between directories and subscriptions.
* Practice managing Azure Active Directories users.
* Explore the characteristics and use cases of Role-Based-Access-Control (RBAC).
* Demonstrate how to create groups, and manage group members and group owners.
* Operate on a hierarchical Azure Active Directory to match the organizational structure.
* Practice managing access to resources and applications in Azure Active Directory.
* Demonstrate how to configure an Azure AD directory to match a real-world scenario.

# Project 3: Resource Provisioning

* Provision and configure a virtual network, subnet, and network security group on Azure.
* Provision Azure virtual machines to host public web server and private database server.
* Automate post-deployment configuration of Azure virtual machines using bash scripts stored on Azure Storage.
* Experiment with network diagnostic tools to test the external connectivity between the Internet and virtual machines and the internal connectivity between virtual machines.
* Update security rules of network security groups to meet the changes of network traffic requirements.

# Project 4: Scalability

* Explain the definition and purpose of scaling.
* Practice vertical scaling by changing the size of the virtual machines on Azure.
* Practice horizontal scaling by changing the number of virtual machines on Azure.
* Experiment with tools of system benchmarking and load testing.
* Practice provisioning a scale set to host a web service and tune the size and number of instances to meet the requirements for performance and cost.

# Project 5: Infrastructure as Code

* Illustrate how the infrastructure evolves over time with growing complexity and scale.
* Describe the advantages of Infrastructure as Code with real-world scenarios.
* Explain the difference between declarative and imperative approaches to manage infrastructure.
* Practice using basic Terraform CLI commands with a prepared example to create a web app in Azure.
* Experiment with provisioners in Terraform to install and start a web service on a virtual machine.
* Explain and practice input variables and output values of Terraform.
* Explain how Terraform stores infrastructure as states and makes incremental changes leveraging the desired state.
* Modify prepared Terraform scripts and apply incremental infrastructure changes.
* Explain resource dependencies in Terraform with examples and visualize the dependencies with graphs.

# Project 6: Monitoring Cloud Services

* Explain the concept and benefits of cloud monitoring.
* Practice configuring autoscale settings of Azure Web App plan using both the Azure portal and Terraform.
* Configure autoscale settings to collect resource metrics and trigger scale actions.
* Explain the workflow of an alert to trigger an action group.
* Practice configuring an availability test of a web app on Azure and set up an alert for test failures using both the Azure portal and Terraform.

# Project 7: Cloud Security

* Discuss the security requirements for deploying applications on the cloud.
* Explain how a multi-layered security strategy provides protection against different and potentially unrelated attack vectors.
* Explain the three ways in which access can be allowed, and denied, for an Azure SQL database.
* Configure firewall rules for an Azure SQL database to implement the Network layer of a multi-layered security strategy.
* Enable server-level auditing on an Azure SQL database to implement the Auditing and Threat Protection layer of a multi-layered security strategy.

# Project 8: Backup and Disaster Recovery

* Describe the importance of business continuity and disaster recovery (BCDR).
* Describe the two solutions provided by Azure Backup service and Azure Site Recovery service to enable the BCDR strategy.
* Set up backup on a VM, configure a backup policy, restore from backup with Azure Backup
* Explain, compare, and apply failover and failback operations.
* Configure, test, and trigger the failover to the secondary region with Azure Site Recovery.
* Experiment with Azure Traffic Manager to deploy a geo-replicated web service.

# Schedule

The tentative schedule is as follows (specific deadlines are posted on OLI and Sail()):

##### 15-week option:

| **Week** | **Conceptual Content on OLI** | **Quiz** | **Hands-on Projects on TPZ** | |
| --- | --- | --- | --- | --- |
| 1 | M1: Cloud Overview |  | P0:  Account and Subscription Setup | |
| 2 | M2: Provisioning and Managing Cloud Services | Quiz 1 | P1:  Subscription and Resource Group Management |  |
| 3 | M3: Identity Management and Access Control | Quiz 2 | P2:  Azure Active Directory |
| 4 | No New Content Week (NNCW) |  |  |
| 5 | M4: Virtualization in the Cloud | Quiz 3 | P3:  Resource Provisioning |  |
| 6 | M5: Elasticity in the Cloud | Quiz 4 | P4:  Scalability |
| 7 | NNCW |  |  |
| 8 | M6: Automation, Configuration and Orchestration | Quiz 5 | P5:  Infrastructure as Code |  |
| 9 | M7: Resource Monitoring | Quiz 6 | P6:  Monitoring Cloud Services |
| 10 | NNCW |  |  |
| 11 | M8: Cloud Security | Quiz 7 | P7:  Cloud Security |  |
| 12 | M9: Disaster recovery and Backup | Quiz 8 | P8:  Backup and Disaster Recovery |
| 13 | NNCW |  |  |
| 14 |  |  | Capstone  Project |  |
| 15 |  |  |  |

##### 8-week option:

| **Week** | **Conceptual Content on OLI** | **Quiz** | **Hands-on Projects on TPZ** |
| --- | --- | --- | --- |
| 1 | M1: Cloud Overview |  | P0: Account and Subscription Setup |
| 2 | M2: Provisioning and Managing Cloud Services | Quiz 1 | P1: Subscription and Resource Group Management |
| 3 | M3: Identity Management and Access Control | Quiz 2 | P2: Azure Active Directory |
| 4 | M4: Virtualization in the Cloud | Quiz 3 | P3: Resource Provisioning |
| 5 | M5: Elasticity in the Cloud | Quiz 4 | P4: Scalability |
| 6 | M6: Automation, Configuration and Orchestration | Quiz 5 | P5: Infrastructure as Code |
| 7 | M7: Resource Monitoring | Quiz 6 | P6: Monitoring Cloud Services |
| 8 | M8: Cloud Security | Quiz 7 | P7: Cloud Security |
| 9 | M9: Disaster recovery and Backup | Quiz 8 | P8: Backup and Disaster Recovery |

# Accommodations for Students with Disabilities

If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@xyz.edu](mailto:access@xyz.edu).

# Take care of yourself

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.