

# Republic of Yemen

Ministry of Higher Education & Scientific Research

## Council of Academic Accreditation & Quality Assurance of Higher Education(CAQA)

21 September University for Medical and Applied Sciences



Faculty of Engineering and Computer  
Department of Information Technology  
Program of Information Technology  
Course Specification of  
Cloud Computing  
Course Code. (07.01. 721)

2024



T4: This Template is Developed and Approved by CAQA-Yemen, 2023

Prepared by:  
Dr. Malek Algabri

Reviewed by:  
Dr. ----

Head of the Department:

Quality Unit:

Dean

## I. General Information:

1.	Course Title:	Cloud Computing				
2.	Course Code:	07.01. 721				
3.	Credit Hours:	Credit Hours	Theory Contact Hours		Practical Contact Hours	
			Lecture	Tutorial/ Seminar	Lab	Clinical
		3	3	--	---	--
4.	Level/ Semester at which this Course is offered:	Level 3/ Semester 2				
5.	Pre –Requisite (if any):					
6.	Co –Requisite (if any):	non				
7.	Program (s) in which the Course is Offered:	Bachelor of Medical Information Technology				
8.	Language of Teaching the Course:	English				
9.	Location of Teaching the Course:	Faculty of Medical Technology				
10.	Prepared by:	Dr. Malek Algabri				
11	Date and Number of Approval by Council:					

## II. Course Description:

This course is designed to give students a theoretical foundation and hands-on experience with the various technologies of the cloud computing paradigm. This course will cover topics related to cloud computing such as cloud-enabling technology, cloud security and cloud infrastructure, security and management mechanisms. Students will also be exposed to various cloud architectures, delivery model considerations & service quality metrics and SLAs. To achieve the course goal different teaching strategies will be applied such as lectures, case studies, problem solving, article reading and self-learning. The prerequisite course for this course is that students must have taken introductory course in networking.

III. Course Intended Learning Outcomes (CILOs) : Upon successful completion of the course, students will be able to:		Referenced PILOs		
<b>A. Knowledge and Understanding:</b>		I, P or M/A		
a1	Provide the students with theoretical aspects and applicable & practical aspects of cloud computing		A1	
a2	Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS		A4	
			A3	
<b>B. Intellectual Skills:</b>				
b1	Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost, and then study how to leverage and manage single and multiple datacenters to build.		B3	
b2	deploy cloud applications that are resilient, elastic and cost-efficient.		B4	
			B3	
<b>C. Professional and Practical Skills:</b>				
c1	Discuss system, network and storage virtualization and outline their role in enabling the cloud computing system model.		C2	
c2	Analyze various cloud programming models and apply them to solve problems on the cloud		C3	
			C3	
<b>D. Transferable Skills:</b>				

d1	demonstrate the Cloud Computing effective communication and negotiation skills		D2	Commit to professional ethics, responsibilities, and norms of professional IT practices
d2			D3	
			D3	
I= Introduced, P=Practiced or M/A= Mastered/Advanced				

(A) Alignment of Course Intended Learning Outcomes (Knowledge and Understanding) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
a1	Provide the students with theoretical aspects and applicable & practical aspects of cloud computing	<ul style="list-style-type: none"> <li>▪ Lectures, Interactive class</li> <li>▪ discussions, Tutorials.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Written exams, assignment</li> <li>▪ work, quizzes, submission of reports</li> </ul>
a2	Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS		
a3		▪	▪
(B) Alignment of Course Intended Learning Outcomes (Intellectual Skills) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
b1	Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost, and then study how to leverage and manage single and multiple datacenters to build.	<ul style="list-style-type: none"> <li>▪ Lectures, Tutorial, Interactive class</li> <li>▪ discussions, and group work,</li> <li>▪ presentation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Written exams, Project, Case</li> <li>▪ studies and assignment work.</li> </ul>
b2	deploy cloud applications that are resilient, elastic and cost-		

	efficient.		
	...	▪	▪
<b>(C) Alignment of Course Intended Learning Outcomes (Professional and Practical Skills) to Teaching Strategies and Assessment Methods:</b>			
	<b>Course Intended Learning Outcomes</b>	<b>Teaching Strategies</b>	<b>Assessment Strategies</b>
c1	Discuss system, network and storage virtualization and outline their role in enabling the cloud computing system model.	<ul style="list-style-type: none"> <li>▪ Short lectures, case study, Laboratory</li> <li>▪ experiments, Project, and group work,</li> <li>▪ Field training, Drawing sessions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Written exams, quizzes, Practical</li> <li>▪ exam assignment and report</li> <li>▪ submission</li> </ul>
c2	Analyze various cloud programming models and apply them to solve problems on the cloud		
	...	▪	▪
		▪	▪
<b>(D) Alignment of Course Intended Learning Outcomes (Transferable Skills) to Teaching Strategies and Assessment Methods:</b>			
	<b>Course Intended Learning Outcomes</b>	<b>Teaching Strategies</b>	<b>Assessment Strategies</b>
d1	demonstrate the Cloud Computing effective communication and negotiation skills	<ul style="list-style-type: none"> <li>▪ Group work, Self-study, Interactive</li> <li>▪ class discussions, Tutorials, Seminar/</li> <li>▪ project/presentation, Laboratory</li> <li>▪ experiments, Project, and Art Gallery</li> </ul>	<ul style="list-style-type: none"> <li>▪ Project presentation, Laboratory</li> <li>▪ exam, Report/Project</li> </ul>
d2			
	...	▪	▪

## IV. Course Contents:

### A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	Introduction	<ul style="list-style-type: none"> <li>▪ Origins and Influences</li> <li>▪ Basic Concepts and Terminology</li> <li>▪ Goals and Benefits</li> <li>▪ Risks and Challenges</li> <li>▪ Fundamental Concepts and Models                             <ul style="list-style-type: none"> <li>○ Roles and Boundaries</li> <li>○ Cloud Characteristics</li> <li>○ Cloud Delivery Models</li> </ul> </li> <li>- Cloud Deployment Models</li> </ul>	1	3	a1,a2
2	Cloud-Enabling Technology	<ul style="list-style-type: none"> <li>▪ Broadband Networks and Internet Architecture</li> <li>▪ Data Center Technology</li> <li>▪ Virtualization Technology</li> <li>▪ Web Technology</li> <li>▪ Multitenant Technology</li> <li>- Service Technology</li> </ul>	1	3	a1,a2,b1
3	Fundamental Cloud Security	<ul style="list-style-type: none"> <li>▪ Basic Terms and Concepts</li> <li>▪ Threat Agents</li> <li>▪ Cloud Security Threats</li> <li>- Additional Considerations</li> </ul>	1	3	a1,a2,b1
4	Cloud Infrastructure Mechanisms	<ul style="list-style-type: none"> <li>▪ Logical Network Perimeter</li> <li>▪ Virtual Server</li> <li>▪ Cloud Storage Device</li> <li>▪ Cloud Usage Monitor</li> <li>▪ Resource Replication</li> <li>- Ready-Made Environment</li> </ul>	1	3	a1,a2,c1,d1
5	Specialized Cloud Mechanisms	<ul style="list-style-type: none"> <li>▪ Automated Scaling Listener</li> <li>▪ Load Balancer</li> <li>▪ SLA Monitor</li> <li>▪ Pay-Per-Use Monitor</li> <li>▪ Audit Monitor</li> <li>▪ Failover System</li> <li>▪ Hypervisor</li> <li>▪ Resource Cluster</li> </ul>	2	6	a1,a2,b2,c1,d1

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
		<ul style="list-style-type: none"> <li>▪ Multi-Device Broker</li> <li>- State Management Database</li> </ul>			
6	Cloud Management Mechanisms	<ul style="list-style-type: none"> <li>▪ Remote Administration System</li> <li>▪ Resource Management System</li> <li>▪ SLA Management System</li> <li>- Billing Management System</li> </ul>	1	3	a1,a2,b2, ,c1,d1
7	Cloud Security Mechanisms	<ul style="list-style-type: none"> <li>▪ Encryption</li> <li>▪ Hashing</li> <li>▪ Digital Signature</li> <li>▪ Public Key Infrastructure (PKI)</li> <li>▪ Identity and Access Management (IAM)</li> <li>▪ Single Sign-On (SSO)</li> <li>▪ Cloud-Based Security Groups</li> <li>- Hardened Virtual Server Images</li> </ul>	2	6	a1,a2 b2 ,c1,d1
8	Mid-term Exam	-	1	3	a1,a2, b2, ,c1,d1
9	Fundamental Cloud Architectures	<ul style="list-style-type: none"> <li>▪ Workload Distribution Architecture</li> <li>▪ Resource Pooling Architecture</li> <li>▪ Dynamic Scalability Architecture</li> <li>▪ Elastic Resource Capacity Architecture</li> <li>▪ Service Load Balancing Architecture</li> </ul>	2	6	a1,1b1,1 c1,d1

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
		<ul style="list-style-type: none"> <li>▪ Cloud Bursting Architecture</li> <li>▪ Elastic Disk Provisioning Architecture</li> <li>- Redundant Storage Architecture</li> </ul>			
10	Advanced Cloud Architectures	<ul style="list-style-type: none"> <li>▪ Hypervisor Clustering Architecture</li> <li>▪ Load Balanced Virtual Server Instances Architecture</li> <li>▪ Non-Disruptive Service Relocation Architecture</li> <li>▪ Zero Downtime Architecture</li> <li>▪ Cloud Balancing Architecture</li> <li>▪ Resource Reservation Architecture</li> <li>▪ Dynamic Failure Detection and Recovery Architecture</li> <li>▪ Bare-Metal Provisioning Architecture</li> <li>▪ Rapid Provisioning Architecture</li> <li>- Storage Workload Management Architecture</li> </ul>	2	6	a1,,b1,c1,d1
11	Cloud Delivery Model Considerations & Service Quality Metrics and SLAs	<ul style="list-style-type: none"> <li>▪ Cloud Delivery Models: The Cloud Provider Perspective</li> <li>▪ Cloud Delivery Models: The Cloud Consumer Perspective</li> <li>▪ Service Quality Metrics</li> <li>- SLA Guidelines</li> </ul>	1	3	a1,b2,c1,d1

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
12	Final exam	- Final Theoretical Exam	1	3	a1,a2 ,b 1,b2,d1
Number of Weeks /and Units Per Semester			16	32	

### B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Week Due	Contact Hours	Learning Outcomes (CILOs)
1	Part 1: Cloud Principles The focus of this topic is to introduce students to the Cloud landscape and its service and deployment models.	2 <sup>nd</sup> , 3 <sup>rd</sup>	4	a1, b1,c1
2	Part 2: Managing Data in the Cloud (Cloud Storage Services) The focus of this topic is to introduce students to the various types of data storage systems that are available for use in the Cloud and illustrate how to interact with these services using a Cloud portal or directly with code	4 <sup>th</sup> ,5 <sup>th</sup>	4	a1, b1,c1
3	Part 3: Cloud-Based Computing and Hosting Services This part of the research program focuses on computing in the Cloud and understanding the spectrum of Cloud computing capabilities used to deploy single virtual machines or containers for simple interactive computing. Students will learn about computing as a service, service platforms, and using/managing virtual machines and docker containers	6 <sup>th</sup>	2	a1, b1,c1
4	Part 4: Scaling Cloud Deployments The focus of this topic is to introduce students to techniques used to scale Cloud deployments via HPC, MapReduce, Graph Dataflow Execution, Agents and Microservices, etc.	7 <sup>th</sup>	2	a1, b1,c1

No.	Tasks/ Experiments	Week Due	Contact Hours	Learning Outcomes (CILOs)
5	Mid-term exam	8 <sup>th</sup>	2	all
6	Part 5: Cloud Networking Services and Service Platform Design The focus of this topic is to introduce students to scalable Cloud computing capabilities used to deploy virtual machines to clusters of machines for data analytics or traditional high-performance computing. Students will also learn about the various platform services available on the Big Clouds.	9 <sup>th</sup> , 10 <sup>th</sup> ,	4	a1, b1,c1
7	Part 6: Cloud Platforms and Big Data Analytics and Machine/Deep Learning Cloud Services Cloud Big Data Analytics Services This topic introduces students to Big Data Science and related challenges and prepares them to use applicable Cloud data analytics and related programming frameworks to implement machine learning applications. Students will learn about data collection, mining, and analytics on the Cloud. Students will also get practical exposure to supervised and unsupervised machine learning algorithms and model fitting.	11 <sup>th</sup>	6	a1,a2, b1, b2, c1, c2
8	Part 7: Cloud Streaming Big Data Analytics Services The focus of this topic is to introduce students to the activity of analyzing data coming from unbounded streams in real-time or near-real-time. This challenging activity is referred to as data stream analytics. An example of such data is that coming from instruments that control complex systems such as the sensors onboard an autonomous vehicle or an energy power grid. In that case, the data analysis is critical to driving the system and the value of the results diminishes rapidly as they get older.	12 <sup>th</sup>	2	a1,a2, b1, b2, c1, c2
9	Part 8: Cloud Machine Learning Services The focus of this topic is to introduce students Machine Learning, a sub-field of Artificial Intelligence, and to Cloud applications of Machine	13 <sup>th</sup>	2	a1,a2, b1, b2, c1, c2

No.	Tasks/ Experiments	Week Due	Contact Hours	Learning Outcomes (CILOs)
	Learning. Recent breakthroughs in this area result from the convergence of the availability of big data, algorithmic advances, and faster computers.			
10	Part 9: Cloud Deep Learning Services (i.e., Cognitive Computing Differentiable Programming) This part of the research program is a continuation of the previous topic. It delves into neuromorphic hardware and cognitive computing and prepares students to use Cloud programming frameworks to implement deep learning applications using differentiable programming. Students will learn about intelligent machines and deep learning networks.	14 <sup>th</sup>	2	a1,a2, b1, b2, c1, c2
11	Final- exam	15 <sup>th</sup>	2	all
<b>Number of Weeks /and Units Per Semester</b>		<b>14</b>	<b>28</b>	

## VII. Assignments:

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
1	Assignment 1: Ideation Assignment	1-10	5	a1,a2, a1,c1,c2, b1,b2,c1,d1,d2
2	Assignment 2: Ideation Presentation	2-12	5	a1,a2, a1,c1,c2, b1,b2,c1,d1,d2
3	Assignment 3: Class Attendance and Participation	Every unit	5	a1,a2, a1,c1,c2, b1,b2,c1,d1,d2
4	In-Class Assignments, Activities & Homework	2-12	5	a1,a2, a1,c1,c2, b1,b2,c1,d1,d2
<b>Total</b>				

## VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignments	1-12	20		a1,a2, a1,c1,c2, b1,b2,c1,d1,d2
2	Mid-Term Theoretical Exam	7-8	20		a1,a2,b1,b2,d1,d 2
3	Final Theoretical Exam	16	60		a1,a2, a1,c1,c2, b1,b2,c1,d1,d2
Total			100		

## IX. Learning Resources:

- *Written in the following order:* Author, Year of publication, Title, Edition, Place of publication, Publisher.

### 1- Required Textbook(s) (maximum two):

- 1- Thomas Erl , Ricardo Puttini , Zaigham Mahmood, 2013, Cloud Computing: Concepts Technology & Architecture (The Prentice Hall Service Technology Series from Thomas Erl), 1st Edition, Prentice Hall, United State.
- 2- R. Chopra, 2017, Cloud Computing: An Introduction, Mercury Learning & Information,

### 2- Essential References:

- 1- Mr. Ray J Rafaels, 2015, Cloud Computing: From Beginning to End. CreateSpace Independent Publishing Platform, USA.
- 2- Arshdeep Bahga , Vijay Madisetti, 2014, Cloud Computing: A Hands-On Approach Hardcover, Vijay Madisetti, India.

### 3- Electronic Materials and Web Sites etc.:

#### Websites:

- 1-

## X. Course Policies: (Based on the Uniform Students' By law (2007))

### Class Attendance:

- 1 Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.



2	<b>Tardiness:</b> A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
3	<b>Exam Attendance/Punctuality:</b> No student shall be allowed to the exam hall after 30 minutes of the start time, and shall not leave the hall before half of the exam time has passed.
4	<b>Assignments &amp; Projects:</b> Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	<b>Cheating:</b> Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
6	<b>Forgery and Impersonation:</b> Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
7	<b>Other policies:</b> The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.



Faculty of Medical Technology  
Department of Medical Information Technology  
Program of Medical Information Technology  
Course Specification of  
Cloud Computing  
Course Code. (07.01. 721)

I. Information about Faculty Member Responsible for the Course:							
Name of Faculty Member:		Office Hours					
Location & Telephone No.:	---						
E-mail:	--@--.	SAT	SUN	MON	TUE	WED	THU

2024/2025

## II. Course Identification and General Information:

	Course Title:	Cloud Computing			
	Course Code:	07.01. 721			
	Credit Hours:	Credit Hours	Theory Contact Hours		Practical Contact Hours
			Lecture	Tutorial/ Seminar	Lab
		3	3	--	---
	Level/ Semester at which this Course is offered:	Level 3/ Semester 2			
	Pre –Requisite (if any):				
	Co –Requisite (if any):	non			
	Program (s) in which the Course is Offered:	Bachelor of Medical Information Technology			
	Language of Teaching the Course:	English			
	Location of Teaching the Course:	Faculty of Medical Technology			
	Prepared by:	Dr. Malek Algabri			
11	Date and Number of Approval by Council:				

## III. Course Description:

This course is designed to give students a theoretical foundation and hands-on experience with the various technologies of the cloud computing paradigm. This course will cover topics related to cloud computing such as cloud-enabling technology, cloud security and cloud infrastructure, security and management mechanisms. Students will

also be exposed to various cloud architectures, delivery model considerations & service quality metrics and SLAs. To achieve the course goal different teaching strategies will be applied such as lectures, case studies, problem solving, article reading and self-learning. The prerequisite course for this course is that students must have taken introductory course in networking.

#### IV. Course Intended Learning Outcomes (CILOs) :

Upon successful completion of the Course, student will be able to:

	<b>A. Knowledge and Understanding:</b>
a1	Provide the students with theoretical aspects and applicable & practical aspects of cloud computing
a2	Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS
	<b>B. Intellectual Skills:</b>
b1	Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost, and then study how to leverage and manage single and multiple datacenters to build.
b2	deploy cloud applications that are resilient, elastic and cost-efficient.
	<b>C. Professional and Practical Skills:</b>
c1	Discuss <b>system, network and storage</b> virtualization and outline their role in enabling the cloud computing system model.
c2	Analyze various cloud programming models and apply them to solve problems on the cloud
	<b>D. Transferable Skills:</b>
d1	<b>demonstrate the Cloud Computing</b> effective communication and negotiation skills
d2	
I= Introduced, P=Practiced or M/A= Mastered/Advanced	

## V. Course Contents:

### A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	Introduction	<ul style="list-style-type: none"> <li>▪ Origins and Influences</li> <li>▪ Basic Concepts and Terminology</li> <li>▪ Goals and Benefits</li> <li>▪ Risks and Challenges</li> <li>▪ Fundamental Concepts and Models                             <ul style="list-style-type: none"> <li>○ Roles and Boundaries</li> <li>○ Cloud Characteristics</li> <li>○ Cloud Delivery Models</li> </ul> </li> <li>– Cloud Deployment Models</li> </ul>	1	3
2	Cloud-Enabling Technology	<ul style="list-style-type: none"> <li>▪ Broadband Networks and Internet Architecture</li> <li>▪ Data Center Technology</li> <li>▪ Virtualization Technology</li> <li>▪ Web Technology</li> <li>▪ Multitenant Technology</li> <li>– Service Technology</li> </ul>	1	3
3	Fundamental Cloud Security	<ul style="list-style-type: none"> <li>▪ Basic Terms and Concepts</li> <li>▪ Threat Agents</li> <li>▪ Cloud Security Threats</li> <li>– Additional Considerations</li> </ul>	1	3
4	Cloud Infrastructure Mechanisms	<ul style="list-style-type: none"> <li>▪ Logical Network Perimeter</li> <li>▪ Virtual Server</li> <li>▪ Cloud Storage Device</li> <li>▪ Cloud Usage Monitor</li> <li>▪ Resource Replication</li> <li>– Ready-Made Environment</li> </ul>	1	3
5	Specialized Cloud Mechanisms	<ul style="list-style-type: none"> <li>▪ Automated Scaling Listener</li> <li>▪ Load Balancer</li> <li>▪ SLA Monitor</li> <li>▪ Pay-Per-Use Monitor</li> <li>▪ Audit Monitor</li> </ul>	2	6

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> <li>▪ Failover System</li> <li>▪ Hypervisor</li> <li>▪ Resource Cluster</li> <li>▪ Multi-Device Broker</li> <li>– State Management Database</li> </ul>		
6	Cloud Management Mechanisms	<ul style="list-style-type: none"> <li>▪ Remote Administration System</li> <li>▪ Resource Management System</li> <li>▪ SLA Management System</li> <li>▪ Billing Management System</li> </ul>	1	3
7	Cloud Security Mechanisms	<ul style="list-style-type: none"> <li>▪ Encryption</li> <li>▪ Hashing</li> <li>▪ Digital Signature</li> <li>▪ Public Key Infrastructure (PKI)</li> <li>▪ Identity and Access Management (IAM)</li> <li>▪ Single Sign-On (SSO)</li> <li>▪ Cloud-Based Security Groups</li> <li>– Hardened Virtual Server Images</li> </ul>	2	6
8	Mid-term Exam	–	1	3
9	Fundamental Cloud Architectures	<ul style="list-style-type: none"> <li>▪ Workload Distribution Architecture</li> <li>▪ Resource Pooling Architecture</li> <li>▪ Dynamic Scalability Architecture</li> <li>▪ Elastic Resource Capacity Architecture</li> <li>▪ Service Load Balancing Architecture</li> </ul>	2	6

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> <li>▪ Cloud Bursting Architecture</li> <li>▪ Elastic Disk Provisioning Architecture</li> <li>– Redundant Storage Architecture</li> </ul>		
10	Advanced Cloud Architectures	<ul style="list-style-type: none"> <li>▪ Hypervisor Clustering Architecture</li> <li>▪ Load Balanced Virtual Server Instances Architecture</li> <li>▪ Non-Disruptive Service Relocation Architecture</li> <li>▪ Zero Downtime Architecture</li> <li>▪ Cloud Balancing Architecture</li> <li>▪ Resource Reservation Architecture</li> <li>▪ Dynamic Failure Detection and Recovery Architecture</li> <li>▪ Bare-Metal Provisioning Architecture</li> <li>▪ Rapid Provisioning Architecture</li> <li>– Storage Workload Management Architecture</li> </ul>	2	6
11	Cloud Delivery Model Considerations & Service Quality Metrics and SLAs	<ul style="list-style-type: none"> <li>▪ Cloud Delivery Models: The Cloud Provider Perspective</li> <li>▪ Cloud Delivery Models: The Cloud Consumer Perspective</li> <li>▪ Service Quality Metrics</li> <li>– SLA Guidelines</li> </ul>	1	3
12	Final exam	Final Theoretical Exam	1	3
<b>Number of Weeks /and Units Per Semester</b>			<b>16</b>	<b>32</b>

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	Introduction	<ul style="list-style-type: none"> <li>▪ Origins and Influences</li> <li>▪ Basic Concepts and Terminology</li> <li>▪ Goals and Benefits</li> <li>▪ Risks and Challenges</li> <li>▪ Fundamental Concepts and Models                             <ul style="list-style-type: none"> <li>○ Roles and Boundaries</li> <li>○ Cloud Characteristics</li> <li>○ Cloud Delivery Models</li> </ul> </li> <li>- Cloud Deployment Models</li> </ul>	1	3
2	Cloud-Enabling Technology	<ul style="list-style-type: none"> <li>▪ Broadband Networks and Internet Architecture</li> <li>▪ Data Center Technology</li> <li>▪ Virtualization Technology</li> <li>▪ Web Technology</li> <li>▪ Multitenant Technology</li> <li>- Service Technology</li> </ul>	1	3
3	Fundamental Cloud Security	<ul style="list-style-type: none"> <li>▪ Basic Terms and Concepts</li> <li>▪ Threat Agents</li> <li>▪ Cloud Security Threats</li> <li>- Additional Considerations</li> </ul>	1	3
4	Cloud Infrastructure Mechanisms	<ul style="list-style-type: none"> <li>▪ Logical Network Perimeter</li> <li>▪ Virtual Server</li> <li>▪ Cloud Storage Device</li> <li>▪ Cloud Usage Monitor</li> <li>▪ Resource Replication</li> <li>- Ready-Made Environment</li> </ul>	1	3
5	Specialized Cloud Mechanisms	<ul style="list-style-type: none"> <li>▪ Automated Scaling Listener</li> <li>▪ Load Balancer</li> <li>▪ SLA Monitor</li> <li>▪ Pay-Per-Use Monitor</li> <li>▪ Audit Monitor</li> <li>▪ Failover System</li> <li>▪ Hypervisor</li> <li>▪ Resource Cluster</li> </ul>	2	6

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> <li>▪ Multi-Device Broker</li> <li>- State Management Database</li> </ul>		
6	Cloud Management Mechanisms	<ul style="list-style-type: none"> <li>▪ Remote Administration System</li> <li>▪ Resource Management System</li> <li>▪ SLA Management System</li> <li>- Billing Management System</li> </ul>	1	3
7	Cloud Security Mechanisms	<ul style="list-style-type: none"> <li>▪ Encryption</li> <li>▪ Hashing</li> <li>▪ Digital Signature</li> <li>▪ Public Key Infrastructure (PKI)</li> <li>▪ Identity and Access Management (IAM)</li> <li>▪ Single Sign-On (SSO)</li> <li>▪ Cloud-Based Security Groups</li> <li>- Hardened Virtual Server Images</li> </ul>	2	6
8	Mid-term Exam	-	1	3
9	Fundamental Cloud Architectures	<ul style="list-style-type: none"> <li>▪ Workload Distribution Architecture</li> <li>▪ Resource Pooling Architecture</li> <li>▪ Dynamic Scalability Architecture</li> <li>▪ Elastic Resource Capacity Architecture</li> <li>▪ Service Load Balancing Architecture</li> <li>▪ Cloud Bursting Architecture</li> <li>▪ Elastic Disk Provisioning Architecture</li> <li>- Redundant Storage Architecture</li> </ul>	2	6

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
10	Advanced Cloud Architectures	<ul style="list-style-type: none"> <li>▪ Hypervisor Clustering Architecture</li> <li>▪ Load Balanced Virtual Server Instances Architecture</li> <li>▪ Non-Disruptive Service Relocation Architecture</li> <li>▪ Zero Downtime Architecture</li> <li>▪ Cloud Balancing Architecture</li> <li>▪ Resource Reservation Architecture</li> <li>▪ Dynamic Failure Detection and Recovery Architecture</li> <li>▪ Bare-Metal Provisioning Architecture</li> <li>▪ Rapid Provisioning Architecture</li> <li>- Storage Workload Management Architecture</li> </ul>	2	6
11	Cloud Delivery Model Considerations & Service Quality Metrics and SLAs	<ul style="list-style-type: none"> <li>▪ Cloud Delivery Models: The Cloud Provider Perspective</li> <li>▪ Cloud Delivery Models: The Cloud Consumer Perspective</li> <li>▪ Service Quality Metrics</li> <li>- SLA Guidelines</li> </ul>	1	3
12	Final exam	- Final Theoretical Exam	1	3
<b>Number of Weeks /and Units Per Semester</b>			<b>16</b>	<b>32</b>

#### B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Week Due	Contact Hours
1	Part 1: Cloud Principles	2nd, 3rd	4

No.	Tasks/ Experiments	Week Due	Contact Hours
	The focus of this topic is to introduce students to the Cloud landscape and its service and deployment models.		
2	Part 2: Managing Data in the Cloud (Cloud Storage Services) The focus of this topic is to introduce students to the various types of data storage systems that are available for use in the Cloud and illustrate how to interact with these services using a Cloud portal or directly with code	4th,5th	4
3	Part 3: Cloud-Based Computing and Hosting Services This part of the research program focuses on computing in the Cloud and understanding the spectrum of Cloud computing capabilities used to deploy single virtual machines or containers for simple interactive computing. Students will learn about computing as a service, service platforms, and using/managing virtual machines and docker containers	6th	2
4	Part 4: Scaling Cloud Deployments The focus of this topic is to introduce students to techniques used to scale Cloud deployments via HPC, MapReduce, Graph Dataflow Execution, Agents and Microservices, etc.	7th	2
5	Mid-term exam	8th	2
6	Part 5: Cloud Networking Services and Service Platform Design The focus of this topic is to introduce students to scalable Cloud computing capabilities used to deploy virtual machines to clusters of machines for data analytics or traditional high-performance computing. Students will also learn about the various platform services available on the Big Clouds.	9th, 10th,	4
7	Part 6: Cloud Platforms and Big Data Analytics and Machine/Deep Learning Cloud Services Cloud Big Data Analytics Services This topic introduces students to Big Data Science and related challenges and prepares them to use applicable Cloud data analytics and related programming frameworks to implement machine learning applications. Students will learn about data collection, mining, and analytics on the Cloud. Students will also get practical exposure to supervised and unsupervised machine learning algorithms and model fitting.	11th	6

No.	Tasks/ Experiments	Week Due	Contact Hours
8	Part 7: Cloud Streaming Big Data Analytics Services The focus of this topic is to introduce students to the activity of analyzing data coming from unbounded streams in real-time or near-real-time. This challenging activity is referred to as data stream analytics. An example of such data is that coming from instruments that control complex systems such as the sensors onboard an autonomous vehicle or an energy power grid. In that case, the data analysis is critical to driving the system and the value of the results diminishes rapidly as they get older.	12th	2
9	Part 8: Cloud Machine Learning Services The focus of this topic is to introduce students Machine Learning, a sub-field of Artificial Intelligence, and to Cloud applications of Machine Learning. Recent breakthroughs in this area result from the convergence of the availability of big data, algorithmic advances, and faster computers.	13th	2
10	Part 9: Cloud Deep Learning Services (i.e., Cognitive Computing Differentiable Programming) This part of the research program is a continuation of the previous topic. It delves into neuromorphic hardware and cognitive computing and prepares students to use Cloud programming frameworks to implement deep learning applications using differentiable programming. Students will learn about intelligent machines and deep learning networks.	14th	2
11	Final- exam	15th	2
<b>Number of Weeks /and Units Per Semester</b>		<b>14</b>	<b>28</b>

No.	Tasks/ Experiments	Week Due	Contact Hours
1	Part 1: Cloud Principles The focus of this topic is to introduce students to the Cloud landscape and its service and deployment models.	2 <sup>nd</sup> , 3 <sup>rd</sup>	4
2	Part 2: Managing Data in the Cloud (Cloud Storage Services) The focus of this topic is to introduce students to the various types of data storage systems that are available for use in the Cloud and illustrate	4 <sup>th</sup> , 5 <sup>th</sup>	4

No.	Tasks/ Experiments	Week Due	Contact Hours
	how to interact with these services using a Cloud portal or directly with code		
3	<p>Part 3: Cloud-Based Computing and Hosting Services</p> <p>This part of the research program focuses on computing in the Cloud and understanding the spectrum of Cloud computing capabilities used to deploy single virtual machines or containers for simple interactive computing. Students will learn about computing as a service, service platforms, and using/managing virtual machines and docker containers</p>	6 <sup>th</sup>	2
4	<p>Part 4: Scaling Cloud Deployments</p> <p>The focus of this topic is to introduce students to techniques used to scale Cloud deployments via HPC, MapReduce, Graph Dataflow Execution, Agents and Microservices, etc.</p>	7 <sup>th</sup>	2
5	Mid-term exam	8 <sup>th</sup>	2
6	<p>Part 5: Cloud Networking Services and Service Platform Design</p> <p>The focus of this topic is to introduce students to scalable Cloud computing capabilities used to deploy virtual machines to clusters of machines for data analytics or traditional high-performance computing. Students will also learn about the various platform services available on the Big Clouds.</p>	9 <sup>th</sup> , 10 <sup>th</sup> ,	4
7	<p>Part 6: Cloud Platforms and Big Data Analytics and Machine/Deep Learning Cloud Services</p> <p>Cloud Big Data Analytics Services</p> <p>This topic introduces students to Big Data Science and related challenges and prepares them to use applicable Cloud data analytics and related programming frameworks to implement machine learning applications. Students will learn about data collection, mining, and analytics on the Cloud. Students will also get practical exposure to supervised and unsupervised machine learning</p>	11 <sup>th</sup>	6

No.	Tasks/ Experiments	Week Due	Contact Hours
	algorithms and model fitting.		
8	<p>Part 7: Cloud Streaming Big Data Analytics Services</p> <p>The focus of this topic is to introduce students to the activity of analyzing data coming from unbounded streams in real-time or near-real-time. This challenging activity is referred to as data stream analytics. An example of such data is that coming from instruments that control complex systems such as the sensors onboard an autonomous vehicle or an energy power grid. In that case, the data analysis is critical to driving the system and the value of the results diminishes rapidly as they get older.</p>	12 <sup>th</sup>	2
9	<p>Part 8: Cloud Machine Learning Services</p> <p>The focus of this topic is to introduce students Machine Learning, a sub-field of Artificial Intelligence, and to Cloud applications of Machine Learning. Recent breakthroughs in this area result from the convergence of the availability of big data, algorithmic advances, and faster computers.</p>	13 <sup>th</sup>	2
10	<p>Part 9: Cloud Deep Learning Services (i.e., Cognitive Computing Differentiable Programming)</p> <p>This part of the research program is a continuation of the previous topic. It delves into neuromorphic hardware and cognitive computing and prepares students to use Cloud programming frameworks to implement deep learning applications using differentiable programming. Students will learn about intelligent machines and deep learning networks.</p>	14 <sup>th</sup>	2
11	Final- exam	15 <sup>th</sup>	2
<b>Number of Weeks /and Units Per Semester</b>		<b>14</b>	<b>28</b>

## VI. Teaching and Learning Strategies of the Course:

☒ Interactive lectures,

- Problem solving,
- Tutorials,
- Seminar/ Project/Presentation,
- Teamwork,
- Laboratory based session,
- Interactive Class Discussions,
- Directed Self- Study,
- Exercises and Home Works,
- Field Visits.

## VII. Assessment Methods of the Course:

- Coursework Activities
- Written tests
- Written assessments such as multiple-choice questions and Quizzes
- Report/Project/ Practical Lab Sessions
- Home works and assignments.
- Presentations

## VIII. Assignments:

No.	Assignments	Week Due	Mark
1	Assignment 1: Ideation Assignment	1-10	5
2	Assignment 2: Ideation Presentation	2-12	5
3	Assignment 3: Class Attendance and Participation	Every unit	5
4	In-Class Assignments, Activities & Homework	2-12	5
<b>Total</b>			

## IX. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Assignments	1-12	20	
2	Mid-Term Theoretical Exam	7-8	20	
3	Final Theoretical Exam	16	60	
<b>Total</b>	<b>100</b>			

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Assignments	1-12	20	
2	Mid-Term Theoretical Exam	7-8	20	
3	Final Theoretical Exam	16	60	
Total			100	

## X. Learning Resources:

- *Written in the following order: Author, Year of publication, Title, Edition, Place of publication, Publisher.*

### 1- Required Textbook(s) (maximum two):

3- Thomas Erl , Ricardo Puttini , Zaigham Mahmood, 2013, Cloud Computing: Concepts Technology & Architecture (The Prentice Hall Service Technology Series from Thomas Erl), 1st Edition, Prentice Hall, United State.

R. Chopra, 2017, Cloud Computing: An Introduction, Mercury Learning & Information,

### 2- Essential References:

1- Mr. Ray J Rafaels, 2015, Cloud Computing: From Beginning to End. CreateSpace Independent Publishing Platform, USA.

Arshdeep Bahga , Vijay Madisetti, 2014, Cloud Computing: A Hands-On Approach Hardcover, Vijay Madisetti, India.

### 3- Electronic Materials and Web Sites etc.:

Websites:

## XI. Course Policies: (Based on the Uniform Students' Bylaw (2007))

1	<b>Class Attendance:</b> Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.
2	<b>Tardiness:</b> A student will be considered late if he/she is not in class after 10 minutes of the start time of class.



3	<b>Exam Attendance/Punctuality:</b> No student shall be allowed to the exam hall after 30 minutes of the start time, and shall not leave the hall before half of the exam time has passed.
4	<b>Assignments &amp; Projects:</b> Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	<b>Cheating:</b> Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
6	<b>Forgery and Impersonation:</b> Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
7	<b>Other policies:</b> The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.