Title (Units): **COMP4057 Distributed and Cloud Computing (3,2,1)**

Course Aims: The objective of this course is to examine techniques underlying the design and engineering of distributed systems and cloud computing systems. Students will also acquire hands-on experience in cloud programming.

Prerequisite: COMP3015 Data Communications and Networking

Course Intended Learning Outcomes (CILOs):
Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
	Knowledge
1	Describe system models for distributed and cloud computing.
2	Describe the design principles of computer clusters and data centers.
3	Describe and distinguish different virtualization techniques.
4	Explain cloud enabling technologies, cloud mechanisms, and cloud architectures.
	Professional Skill
5	Use cloud programming (e.g., Google App Engine, Amazon Web Services) to solve real problems.
	Attitude
6	Solve problems and exhibit self-learning abilities in distributed and cloud computing.

Calendar Description: This course introduces the techniques underlying the design and engineering of distributed systems and cloud computing systems. Topics include distributed system models, computer clusters, virtualization, data centers, cloud computing models, cloud-enabling technologies, cloud mechanisms, and cloud architectures. Students will also acquire hands-on experience in cloud programming.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-4	Students will learn various design principles in distributed and cloud computing via lectures and assignments
5, 6	Students will acquire hands-on experience in cloud programming via lectures and machine problems.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Programming labs and assignments	20%	4 - 6	Lab exercises are designed to evaluate students' understanding on cloud concepts and cloud programming. Assignments of machine problems are designed to evaluate the student's understanding in distributed and cloud computing as well as the proficiency in using cloud programming to solve real-world problems.
2	Midterm	20%	1 - 4	Midterm test(s) are designed to test evaluate the students' understanding in distributed and cloud computing as well as the ability in using cloud programming
3	Examination	60%	1 - 4	Final examination questions are to evaluate learning outcomes in the knowledge domain. Questions are to test students' thorough understanding on the principles of distributed and cloud computing.

Assessment Rubrics:

	Excellent (A)	Good (B)	Satisfactory (C)	Marginal Pass (D)	Fail (F)
Describe the various design issues in distributed systems and cloud computing platforms	Fully understand all the design issues	Understand most of the design issues	Sufficiently understand the design issues	Understand a minimum set of design issues	Does not understand most of the issues
Describe the design principles of computer clusters for scalable computing	Fully understand the design principles of computer clusters	Understand most of the design principles of computer clusters	Sufficiently understand design principles of computer clusters	Understand a minimum set of design principles of computer clusters	Does not understand most of the design principles of computer clusters
Describe the principles and techniques of virtualization of IT resources and data centers	Fully understand the principles and techniques of virtualization of IT resources and data centers	Understand most of the principles and techniques of virtualization of IT resources and data centers	Sufficiently understand the principles and techniques of virtualization of IT resources and data centers	Understand a minimum set of the principles and techniques of virtualization of IT resources and data centers	Does not understand most of the principles and techniques of virtualization of IT resources and data centers
Explain cloud-enabling technologies, cloud mechanisms, and cloud architectures	Fully explain cloud-enabling technologies, cloud mechanisms, and cloud architectures	Explain most of cloud-enabling technologies, cloud mechanisms, and cloud architectures	Sufficiently explain cloud-enabling technologies, cloud mechanisms, and cloud architectures	Explain a minimum set of cloud-enabling technologies, cloud mechanisms, and cloud architectures	Does not explain most of cloud-enabling technologies, cloud mechanisms, and cloud architectures
Carry out cloud programming to solve problems (e.g., Google App Engine or Amazon Web Services)	Demonstrate a high degree of effectiveness and correctness in using cloud programming for problem solving	Demonstrate a considerable degree of effectiveness and correctness in using cloud programming for problem solving	Demonstrate a considerable degree of correctness in using cloud programming for problem solving	Demonstrate some degree of correctness in using cloud programming for problem solving	Does not have the ability to correctly use cloud programming for problem solving

Course Content and CILOs Mapping:

Content		CILO No.
I	Distributed System Models and Enabling Technologies	1, 4
II	Design Concepts and Technical Issues in Distributed Computing	1, 2, 4
III	Computer Clusters for Scalable Computing	2
IV	Concepts and Models of Cloud Computing	1, 3
V	Cloud-Enabling Technologies	2, 3, 4
VI	Cloud Computing Mechanisms and Architectures	3, 4
VII	Cloud Programming Platforms	5, 6

References:

- George Coulouris, Jean Dollimore, T. Kindberg, and Gordon Blair, Distributed Systems: Concepts and Design, 5th Edition, Addison Wesley, 2012.
- Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.
- Kai Hwang, Jack Dongarra, and Geoffrey C. Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, 1st Edition, Morgan Kaufmann, 2011.

- Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd Edition, Prentice Hall, 2006.

Course Content:

Topic

I. Distributed System Models and Enabling Technologies
   A. Characteristics of Distributed Computing
   B. System Models for Distributed Computing
   C. Performance and Security Issues in Distributed Systems

II. Design Concepts and Technical Issues in Distributed Computing
   A. Synchronization & Global States
   B. Coordination & Agreement
   C. Transactions & Concurrency Control
   D. Replication & Fault Tolerance

III. Computer Clusters for Scalable Computing
   A. Clustering for Massive Parallelism
   B. Computer Clusters and MPP Architectures
   C. Design Principles of Computer Clusters
   D. Cluster Job and Resource Management
   E. Case Studies

IV. Concepts and Models of Cloud Computing
   A. Basic Concepts and Terminology
   B. Cloud Delivery Models
   C. Cloud Deployment Models

V. Cloud-Enabling Technologies
   A. Networking Technology for Cloud Computing
   B. Storage Technology for Cloud Computing
   C. Virtualization Technology
   D. Data Center Architecture and Technology

VI. Cloud Computing Mechanisms and Architectures
   A. Cloud Infrastructure Mechanisms
   B. Specialized Cloud Mechanisms
   C. Cloud Management Mechanisms
   D. Cloud Security Mechanisms
   E. Cloud Computing Architectures

VII. Cloud Programming Platforms
   A. Features of Cloud Programming
   B. Case Studies (e.g., Google App Engine, Amazon Web Services)
   C. Problem Solving with Cloud Programming