Title (Units): **COMP7180 Quantitative Methods for Data Analytics and Artificial Intelligence (3,2,1)**

Course Aims: To learn the various quantitative methods necessary for data analytics and artificial intelligence. To master the numeracy approach and quantitative reasoning for problem-solving in data analytics and artificial intelligence.

Prerequisite: Nil

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 the essential concepts in linear algebra for data analytics and artificial intelligence
2	Understand fundamental univariable and multivariable differentiation and calculus for data analytics and artificial intelligence
3	Explain the essential concepts in probability and statistics for data analytics and artificial intelligence
4	Understand the essential concepts in optimization for data analytics and artificial intelligence
	Professional Skill
5	Determine suitable quantitative methods for effective data analytics
6	Apply suitable quantitative methods for real-world problem solving

Calendar Description: This course aims to introduce various quantitative methods that are necessary for data analytics and artificial intelligence. It takes a computational approach in teaching the quantitative methods such as linear algebra, univariable and multivariable differentiation and calculus, probability and statistics, and optimization. Students will learn and master the concepts of quantitative methods through analyzing representative data analytics and artificial intelligence models/algorithms; and meanwhile they will acquire problem-solving skills for data analytics and artificial intelligence.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-4	Students will learn the quantitative methods through lectures, in-class exercises, quizzes, and assignments.
5-6	Students will learn the problem-solving skills using quantitative methods through lectures, tutorials, and assignments.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Continuous Assessment	40%	1-6	Assignments and quizzes/tests are designed to assess how well students have learned the quantitative methods and the students' ability in determining suitable quantitative methods for real-world problem solving.
2	Examination	60%	1-6	Final examination questions are designed to assess how far students have achieved in understanding and applying quantitative methods for data analytics and artificial intelligence.

Assessment Rubrics:

	Excellent (A)	Good (B)	Satisfactory (C)	Fail (F)

Linear algebra, univariable and multivariable differentiation and calculus, probability and statistics, and optimization	Excellent knowledge in the selected topics of linear algebra, univariable and multivariable differentiation and calculus, probability and statistics, and optimization	Sufficient knowledge in the selected topics of linear algebra, univariable and multivariable differentiation and calculus, probability and statistics, and optimization	Average knowledge in the selected topics of linear algebra, univariable and multivariable differentiation and calculus, probability and statistics, and optimization	Inadequate knowledge in the selected topics of linear algebra, univariable and multivariable differentiation and calculus, probability and statistics, and optimization

Course Content and CILOs Mapping:

Content		**CILO No.**
I	Linear Algebra	1,5,6
II	Univariable and Multivariable Differentiation and Calculus	2,5,6
III	Probability and Statistics	3,5,6
IV	Optimization	4,5,6

References:

- Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 1st Edition, 2020.
- Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning, Springer, 1st Edition, 2020.
- Eric Lehman, F. Thomson Leighton, Albert R. Meyer, Mathematics for Computer Science, Samurai Media Limited, March 2017.
- Joel Grus, Data Science from Scratch, 1st Edition, O'Reilly, April 2015.
- Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley, August 2011.
- Allen B. Downey, Think Stat, 1st Edition, O'Reilly, July 2011.

Course Content:

Topic

I. Linear Algebra
   A. Basic vector and matrix operations
   B. Matrix properties: trace, rank, range, and determinant
   C. Eigenvalues and eigenvectors
   D. Application of linear algebra in DAAI: Principal component analysis
   E. Application of linear algebra in DAAI: Singular value decomposition

II. Univariable and Multivariable Differentiation and Calculus
   A. Introduction to artificial intelligence and machine learning
   B. Partial derivatives and gradients
   C. Multivariable chain rule
   D. Jacobian and Hessian matrices
   E. Application of differentiation and calculus in DAAI: Regression analysis

III. Probability and Statistics
   A. Conditional probability and independence
   B. Discrete and continuous random variables
   C. Expectation and variance

D. Multiple random variables
E. Application of probability and statistics in DAAI: Maximum likelihood estimation

IV. Optimization
A. Mathematical optimization
B. Convex sets and convex functions
C. Least squares and convex optimization
D. Non-convex optimization
E. Application of optimization in DAAI: Gradient descent methods